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ENGINEERING AND

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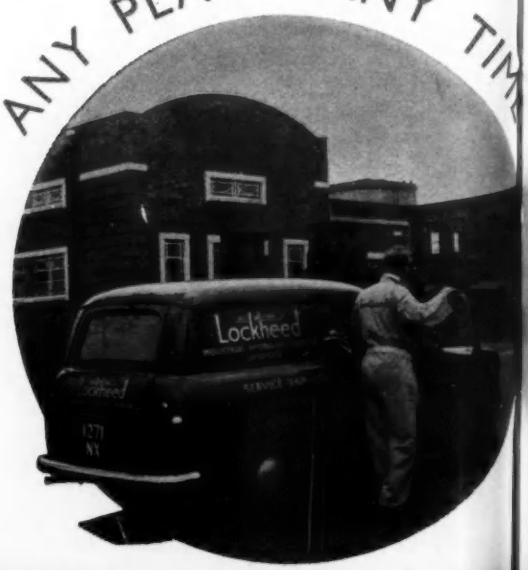

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THE OLDEST ESTABLISHED STEAM ENGINEERING PUBLICATION

JULY 1961

VOLUME 76. No. 7

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The Editor will be glad to receive and consider original contributions, correspondence, etc., of a suitable nature for publication. Stamped and addressed envelopes should be enclosed for the return of any matter considered unsuitable

Published monthly by

ENGINEERING REVIEW PUBLISHING CO. LTD.
19-20, NOEL STREET, LONDON, W.1

Annual Subscription Rate, 40s., including postage.

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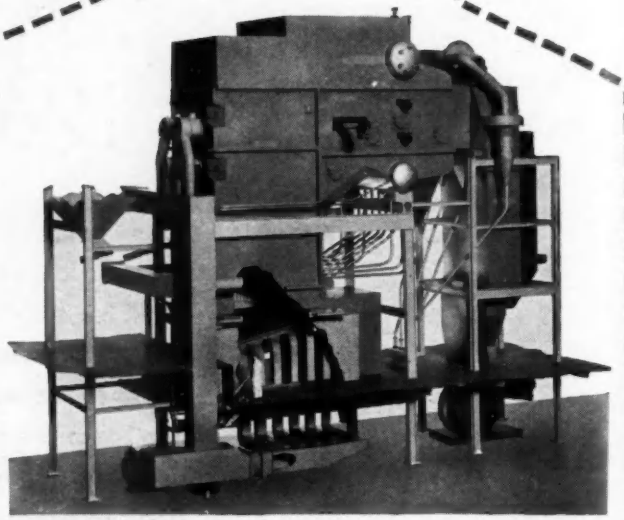
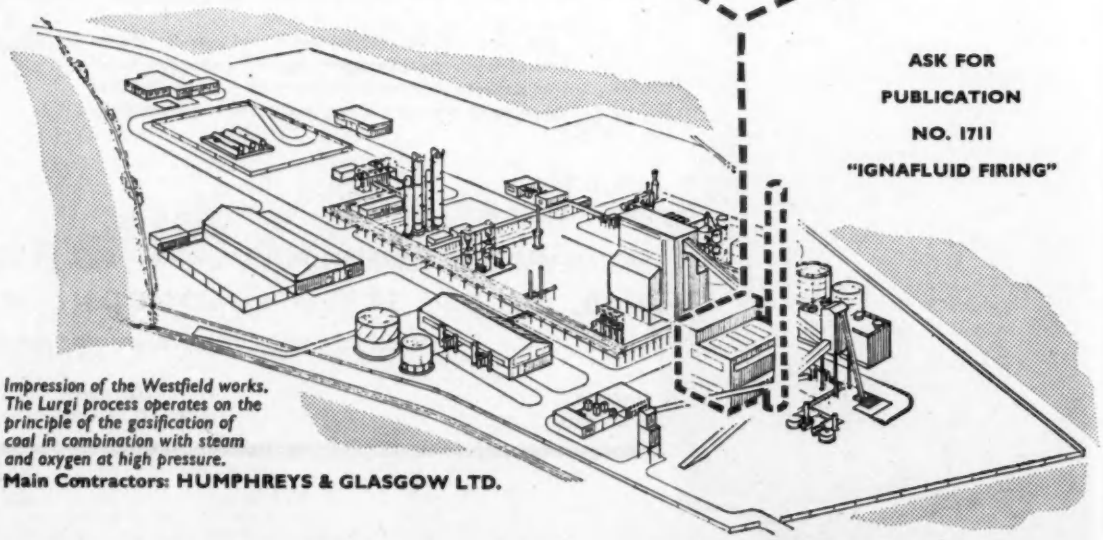
supply steam to Britain's first Lurgi high-pressure gasification plant

Three 45,000 lb./hr. Babcock Bi-drum boilers supply steam, at 450 lb./sq. in. to the new Lurgi high-pressure gasification plant of the Scottish Gas Board, at Westfield, Fife—first of its kind in Britain. This is also the first application in Britain of **Ignafluid firing,** developed by Babcock for the efficient combustion of fine, unmilled, low-grade fuels, including even coke-breeze dust and with ash-contents up to 40%, in boilers and some types of industrial furnace. The specification of Babcock boilers with **Ignafluid firing** is in keeping with the whole modern conception of the Westfield plant*, which is an important advance in British gas-production and in the development of the Scottish gas grid.



Cut-away view (from a model) of a Bi-drum boiler with Ignafluid firing: showing the inclined travelling grate for slag-removal and divided ducting for the pulsating primary-air supply.



Impression of the Westfield works. The Lurgi process operates on the principle of the gasification of coal in combination with steam and oxygen at high pressure.

***Main Contractors: HUMPHREYS & GLASGOW LTD.**

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Engineering and BOILER HOUSE REVIEW

JULY 1961
VOLUME 76 No. 7

FUTURE OF ELECTRICITY IN BRITAIN

THE presidential address to the British Electrical Power Convention, held in Eastbourne from June 12th to 15th, was given by Sir John Pickles, chairman of the South of Scotland Electricity Board. Sir John's address ranged over the present and future of electricity supply in Great Britain. After briefly reviewing the progress of the industry during two 40-year periods, 1880 to 1920 and 1920 to 1960, Sir John turned to the possible lines of development during the 40 years up to 2000. Despite its remarkable growth, electrical energy still continued rapidly to supersede other forms of energy in established fields, and to be the first choice in new and expanding ones. All the Electricity Boards, Sir John said, could testify to the avalanche of load reaching them from domestic and commercial premises.

To take only one aspect of the immediate future, no other recent measure has a greater potential effect on electricity developments than the Clean Air Act of 1956. Apart from its immediate impact on the design of all new buildings, the Act should result in the next 10 or 15 years in at least six million existing dwelling houses, and over one million commercial premises being changed from the burning of raw coal to the smokeless fuels, such as prepared coal, coke, oil, gas and electricity. In heavy industry, individual new loads of 50-MW to 100-MW and over were not uncommon. The picture was one of all-round expansion of the use of electrical energy, and every new use seemed to pave the way to yet another use. Last year, the consumption increased by 13 per cent. The supply industry's costs placed it in a most favourable position to compete with other fuels. Electricity was at the root of the objects for which they were all striving—elimination of drudgery, saving of manpower, better health and an improved standard of living. In short, Sir John said, the industry seemed posed for a further period of continued expansion on a very substantial scale. But, Sir John asked, could consumption go on doubling every 10 years ? Were they in danger of regarding this as an immutable law ? To continue at this rate for the next 40 years would mean, even allowing for greatly improved load factor, that the present installed generating capacity of some 30,000-MW would rise to over 400,000-MW;—a prospect which manufacturers would no doubt relish, but a formidable thought by any standard.

An international comparison had shown that long-term estimates of electricity demand tended to be conservative. In the U.S.A., consumption per head, which was already 4,500 units, was expected to rise to at least 20,000 by the year 2000. The present British figure of annual consumption per head was slightly over 2000 units. Sir John did not think it impracticable for the 1970 consumption to be doubled again, possibly by 1980 or by 1985 at the latest. In generation, it implied that installed capacity would have increased to about 60,000-MW by 1970, and to more than 100,000-MW by 1980/1985. The coal availability ceiling would have been passed and, towards the end of the period, it seemed likely that the greater part of new generating plant would be nuclear. But, due to its low capital cost, conventional thermal plant might still be justified, especially for replacement in existing buildings. The 1,000-MW set might have made its debut—an 800-MW set had already been ordered in the U.S.A. The operation of large generating sets and boilers would be controlled by computers. In transmission, still higher voltages would have to be adopted—a 750 kV system seemed not unlikely.

Distribution would have necessitated greatly extended high-voltage systems with transformers for every 20 houses or so. This meant that transformers must be much improved in compactness and reduced noise levels, and that switchgear must be simplified and cheapened. Sir John thought that insulation and low-voltage underground cables, if not all high-voltage cables, would be of the extruded plastic type, possibly without metallic sheathing. Many modern buildings already required high-voltage vertical distribution cables and this type of insulation would become commonplace.

On the commercial and utilisation side, Sir John continued, electricity would become much easier to sell, and commercial staff would be more concerned with service than with selling. The quarterly meter reading and account will have been replaced, perhaps, by a fixed monthly charge adjusted to meter readings made once or, at the most, twice a year. The industry would gradually approach and might well attain a position of complete self financing.

Looking further ahead, Sir John said that if there was no more than a 3 per cent. increase in installed generating capacity after 1985, the plant installed would exceed 150,000-MW by the end of the century. With a 5 per cent. increase, 200,000-MW of plant would be required. A vital question then would be what fuels would be available. Since fossil fuels were a wasting asset, no-one could doubt the prudence of searching for other forms of energy even though their contribution might be limited. Sir John said he was certain that those in charge of the industry in the eighties, and experiencing the real pinch of shortage of coal and oil would applaud the nuclear pioneering being done. But if fission provided a cheap and reliable means of generation, was it possible that the enormous cost of research and development of fusion would not be justified for what might be only marginal gains. Again, Sir John thought that thermionic, and thermo-electric generation were so highly speculative that they could be allotted to the next century, but magneto-hydro-dynamic generation, was more promising. The other possibilities were the d.c. transmission to the Midlands of peak supplies from the pumped-storage plants in the Highlands, and a " Euro-Electricity " system that would permit exchange of energy throughout Europe. In conclusion, Sir John said there would be many problems, but, with inspired leadership, all must and would be overcome. Society would not tolerate restriction in a service so desirable and so vital to the Convention theme—" The Prosperity and Welfare of the Nation."

Points and Pointers

ENGINEERING INSPECTION AND NON-DESTRUCTIVE TESTING

Those who are concerned with engineering inspection and non-destructive testing will be interested in a National Conference which is to be held at Oxford in September, 1961, to discuss the function of management in relation to inspection, the economics of inspection and non-destructive testing, and the recruitment, education and training of inspection staffs. This conference is being planned at the request of the Joint Committee of Materials and their Testing, and the British National Committee for Non-Destructive Testing. It is being organised jointly by the Institution of Engineering Inspection, and the Society of Non-Destructive Examination. The speakers invited are all closely associated with their subjects and have wide experience in the fields concerned. Sessions will be arranged to allow ample time for discussion. In view of the wide interest already expressed by industry, learned societies and the teaching profession, residential accommodation at Queen's College and New College, Oxford, has been reserved over the period September 5th to 8th, 1961. The total cost, including conference fee, accommodation and all meals in college will be £9 10s. 0d. per delegate. Those who wish to have further information should write to the Oxford Conference Secretariat, The Institution of Engineering Inspection, 616, Grand Buildings, Trafalgar Square, London, W.C.2. This will involve no obligation, but will ensure that full details will be sent as soon as they are available.

ELECTRICAL AND ALLIED ENGINEERING EXPORTS

The British Electrical and Allied Manufacturers' Association has published a new edition of its guide "Territorial Analysis of British Exports of Electrical and Allied Machinery and Apparatus." The guide, which has been compiled as part of B.E.A.M.A.'s service to provide basic data for exporters in the electrical manufacturing industry, takes the form of a comprehensive analysis of United Kingdom exports of electrical and allied engineering equipment over the past three years, 1958-1960. It shows the values of exports from this country to 85 different destinations under 80 different product headings in the electrical field, and also includes summary details of exports to the Commonwealth and European countries separately. A three-year comparison is given for each individual item so that the progress of every product can be readily assessed, while a short introductory article summarises the chief trends of the industry's export performance. Electrical and allied engineering products form one of the largest groups in the United Kingdom's export accounts. Last year they amounted to more than one tenth of the country's total exports of manufactured goods, reaching a grand total of £293·4 million. Since 1950 the annual total has increased by 83 per cent. from £160 million to £293 million. About one third of the industry's exports consists of electrical power plant machinery and industrial equipment, and other major categories are electronic and telecommunications apparatus, domestic electrical appliances and electric cables.

INTERNATIONAL COMBUSTION (HOLDINGS) LIMITED/THE SUPERHEATER CO. LTD.

The Boards of International Combustion (Holdings) Limited and the Superheater Co. Ltd. have reached agreement with a view to the Superheater Co. joining the International Combustion group. The merger will be effected by an offer on behalf of International Combustion to acquire the issued share capital of the Superheater Co. on the basis of seven 5s. ordinary shares of International Combustion for every 10 Superheater ordinary or "A" ordinary 5s. shares. The Boards of both companies and their advisers are of the opinion that having regard to all considerations, particularly future prospects, the merger is in the best interests of the shareholders and employees of the two companies. The Board of the Superheater Co. have ascertained that its majority shareholder—Combustion Engineering Inc., New York (holding some 50·6 per cent. of the issued ordinary shares and some 43.3 per cent. of the issued "A" shares), regards the offer as fair and reasonable and intends to accept it. The directors themselves also propose to accept the offer in respect of their own holdings and strongly recommend other shareholders to do likewise. The major business of the International Combustion group lies in the design and construction of different types of water tube boilers for central power station and industrial steam generation purposes. Since its inception the company has had a close technical liaison with Combustion Engineering Inc. of New York, and it has accordingly also been in similarly close association with the Superheater Co. which in consequence has been the major supplier of steam superheaters and reheaters for International Combustion boiler plant. The rapid increases which have taken place in recent years in the size of boiler plant and in the pressures and temperatures at which such plant is nowadays required to operate, has resulted in orders for fewer but larger boiler units. This has brought about a considerable rationalisation of the boilermaking industry which has included a grouping and pooling of resources among the main manufacturers. As a result not only has the technical and commercial liaison between International Combustion and the Superheater Co. become of greater importance but the Superheater Co. is tending to become increasingly dependent for orders on International Combustion Limited. The Boards of both companies have come to the conclusion that it is essential to the continued progress of them both that they should co-operate in the future under such conditions as can be achieved only by a complete merger of their respective interests. The Board of International Combustion Limited are satisfied that future prospects are brighter than they were a year ago

and that in due course this improvement should be reflected in earnings. Although profits for the current year will certainly not exceed those for last year, it is hoped, subject to any unforeseen circumstances, that it will be possible to maintain at the increased capital, the total rate of dividend of 30 per cent. (less tax) paid in respect of the year ended September 30th, 1960. It is intended that the Superheater Co. shall retain its identity and continue to trade under its own name.

WORLD SCIENTISTS' MEETING

More than 100 scientists from all over the world attended a nuclear power conference organised by the Central Electricity Generating Board which was held recently at Berkeley, Gloucestershire. The subject of the meeting was "Properties of Reactor Materials and the Effects of Radiation Damage." The delegates came from many different countries, France being represented by 16 scientists, and the United States by 12. The conference followed the official opening of the nuclear power station laboratories at Berkeley, which have been established by the Generating Board to carry out research and development work in connection with Britain's civil nuclear power programme. At the opening session of the conference, papers were presented by G. H. Kinchin and Dr. W. M. Lomer of the United Kingdom Atomic Energy Authority, and by Professor F. Seitz of the University of Illinois. Opening the conference, Sir Christopher Hinton, Chairman of the Generating Board, said: "In the early days of atomic energy, an exchange of thought was impossible because work was then done within the field of the defence industry. But with the first Geneva conference, a great step forward was taken, and that conference paved the way towards an extensive exchange of information on an international basis. Since that conference, atomic power has established its position in the electricity supply industry. In that industry, there is already a long established international freemasonry for the interchange of research information. That exchange of information ensures that widest competition is retained while unduly wasteful duplication of research is avoided. It is within the spirit that the Berkeley conference was held."

KNIGHTHOOD FOR MR. W. KENNETH G. ALLEN

The announcement in the Queen's Birthday Honours of the award of a Knighthood to Mr. W. Kenneth G. Allen, chairman and managing director of W. H. Allen Sons & Co. Ltd., Bedford, and chairman of Gwynnes Pumps Limited, Lincoln, was received with much pleasure in Bedfordshire, and in the engineering industry generally. Born in Bedford in 1907, Mr. Allen was educated at Westminster School and at the University of Neuchatel, Switzerland. He commenced his career as an engineering pupil first with Harland & Wolff Limited, Glasgow and Belfast, and later at Queens Engineering Works, Bedford, subsequently obtaining experience in the main technical and commercial departments of the organisation. He joined the Board of W. H. Allen Sons & Co. Ltd. in 1937, becoming managing director in 1946, and in September, 1955, was elected chairman of the company in succession to his uncle, the late Sir Richard W. Allen—being the third member of the Allen family to become chairman since the company was founded by his grandfather, Mr. W. H. Allen, in 1880. During Mr. Kenneth Allen's chairmanship the company has expanded considerably, with new building developments at both Queens and Biddenham Works, the multi-storey office block at Queens Works and the new Research Centre, as well as the new Hydraulic Test House, now nearing completion at Biddenham Works, being particularly noticeable. In addition, in late 1955, the company purchased Atlas Works at Pershore, Worcestershire, for the extended manufacture of gearing products; in June, 1960, the premises of John P. White & Sons Limited, which adjoin the north end of Queens Works at Bedford; and in the autumn of 1960, Gwynnes Pumps Limited, Lincoln, now a wholly-owned subsidiary. He is also director of Whessoe Limited, Darlington. Mr. Kenneth Allen has for many years been actively associated with important bodies and associations in the industrial sphere, and is at present a member of the Councils of the British Internal Combustion Engine Manufacturers' Association (of which he is a past chairman), and the British Engineers' Association (of which he is a past president). He also holds the office of a Counsellor of the British Electrical and Allied Manufacturers' Association, of which he was Chairman of the Council for the two years up to March, 1961.

CURRENT PRACTICE IN FUEL EFFICIENCY

The eighth annual refresher course on Current Practice in Fuel Efficiency is to be held at the Clarendon Laboratory, Oxford, from September 25th to 29th, 1961. This N.I.F.E.S. annual residential refresher course has become established nationally as one of the most comprehensive courses of its kind. It covers a wide range of subjects, and presents a unique opportunity for works managers, works and plant engineers, and technical staff of industrial, municipal and public undertakings to acquire up-to-date information on developments and research into the more efficient use of fuels, plant and processing—so vital to reducing costs and increasing productivity. Every endeavour is made to vary the content of the programme each year, and particular attention is paid by the various speakers to the aspects of practical application when giving lectures. Of the 90 min. allotted to each talk, the second 45 min. is devoted to questions during which, those attending are invited to put forward their individual problems. This year, there will be 17 sessions which include three evening periods. The day sessions will be held in the main lecture theatre of the Clarendon Laboratory, while the evening sessions, which will be of an informal character, will be held at Brasenose College. For resident members the registration fee—covering the whole course, accommodation and meals—will be 16 guineas. For non-resident members, the registration fee—covering the whole course plus coffee, lunch and tea daily—will be £11. Application forms for membership of the course, details of the programme, etc., may be obtained from the Course Secretary, Eighth Annual Refresher Course, National Industrial Fuel Efficiency Service, Ailsa House, 181, Kings Road, Reading, Berks. Application forms should be returned to the Secretary as soon as possible, and certainly not later than Monday, September 11th, together with a remittance (payable to the National Industrial Fuel Efficiency Service) in respect of each person.

Belfast Power Station West

TO mark the completion of the £15 million Belfast Municipal Power Station West, Lord Brookeborough, Prime Minister of Northern Ireland, unveiled, on May 5th, a commemorative plaque in the entrance hall. The station has an installed generating capacity of 240-MW—the plant comprising two 30-MW and three 60-MW turbo-alternator sets—the associated boiler plant consisting of four units each of 180,000 lb./hr., and nine units each of 220,000 lb./hr. capacity. The construction of this coal-fired station was commenced in 1951, and the first 30-MW unit went into commission three years later. It was in 1949 that forecasts of future electrical power demands indicated that, to meet the estimated peak load of 1954, additional generating plant would have to be added to supply the Northern Ireland Grid. Consequently, the Ministry of Commerce advised the Belfast Corporation that, following a recommendation of the Northern Ireland Joint Electricity Committee, the Ministry proposed to prepare a scheme providing for the establishment of a new generating station, and requested the corporation to take preliminary steps such as selecting a site, design of the requisite plant, and the preparation of estimates.

Suitable sites in Northern Ireland for a conventional fuel power station are not numerous, when one bears in mind the specific requirements. These necessitate adequate cooling-water supplies from sea or river, facilities for berthing and discharging modern colliers, suitable access (preferably with existing roads) within economic distance of the electricity distribution area, and with subsoil having good load-bearing ability. Water and berthing requirements ruled out inland sites, and the only coastal area reasonably adjacent to the load area was near Belfast. A site within the boundaries of the Belfast Harbour Commissioners was therefore an almost automatic selection, and some 14 acres on the West Twin Island were offered and accepted. On September 26th, 1954, the first 30-MW unit went into commission and the station was officially commissioned on May 6th, 1955, by His Excellency, The Governor of Northern Ireland, The Lord Wakehurst, K.C.M.G. An illustrated description of this first section of the station was published in the October 1955 issue of ENGINEERING AND BOILER HOUSE REVIEW.

The close estimating in the early part of 1949 having been substantiated by the maximum loads of subsequent years, there was every justification for basing plant requirements beyond 1954 on a continuing increase of 8 per cent. per annum. The resulting computation indicated the necessity for additional plant to meet the 1957 estimated peak load; and consequently in August 1951, the Ministry of Commerce advised the Belfast Corporation that it had been decided to extend the capacity of the station by the addition of two 60-MW turbo-alternators. The scheme was confirmed in August 1952, and two years later a further extension of one 60-MW turbo-alternator was confirmed, thereby fixing the final capacity of the power station at 240-MW.

This preliminary information was useful insofar as it enabled the Corporation to envisage with greater accuracy the ultimate requirements of certain portions of the initial installation, particularly those for circulating-water supply and coal-handling. With the station capacity fixed at 240-MW, the limit of site accommodation had been reached, and although small additions to the area had been obtained from the Harbour Commissioners, the original ratio of 4.3-MW per acre now became 17-MW per acre which is by no means generous where the largest unit of plant is some 60-MW. However, notwithstanding the congestion that site limitations imposed, the estimated peak load of 1957 was the target that had to be met, and difficulties and inconveniences had to be overcome and the speed of erection maintained. So effectively was this done that the first 60-MW turbo-alternator set was synchronised on September 15th, 1957, the second unit was commissioned on December 17th, 1957, and installation was completed when the third unit was commissioned on October 18th, 1958.

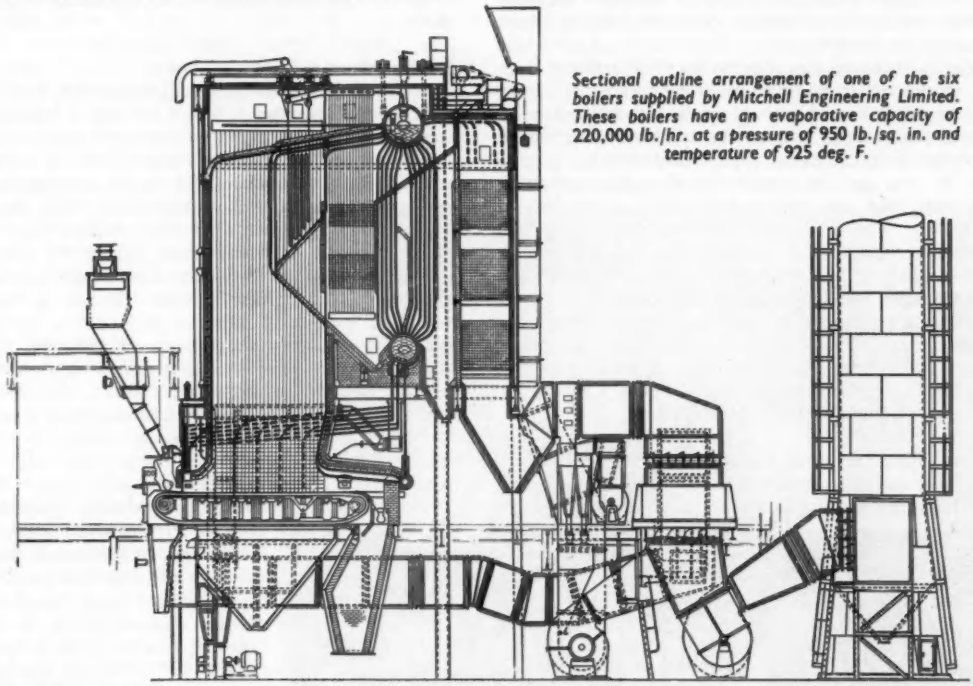
The "West Twin Island" site consists substantially of made-up ground having a general site-level, about 8 ft. above high-tide level. Although part of the area

Belfast Power Station West which has recently been completed by the Belfast Corporation Electricity Dept. The station now has an installed generating capacity of 240 MW, the boiler plant comprising four 180,000 lb./hr., and nine 220,000 lb./hr. units.

had been occupied during the last war, it was mostly very rough ground, indented on the east side with a sheet-piled basin.

Test borings showed that whilst the levels of load-bearing strata varied throughout the site, they were on the average 50 ft. below ground surface, and that piling would have to form a major part of all foundation work. It was also obvious that all large and deep excavations would require to be protected by sheet-piling. For the completed station, some 7,000 piles have been used. The majority were of reinforced-concrete, 16 in. or 14 in. square-section and cast on the site. Little trouble was experienced in driving, practically no underground obstructions were met, and there was little resistance during the first stages due to the extent of the usual Belfast sleech. The most intricate section of the civil engineering works was the construction of the circulating-water system comprising the intake, pumphouse, outfall works and connecting culverts. Due to the formation of the east bank of the Herdman Channel, and the future development schemes of the Harbour Commissioners, it was possible to construct the intake structure with its power-operated penstocks inside a sheet-piled cofferdam "in the dry." The bank was finally trimmed back by dredging, and the structure is now in deep-water, remote from the bank and approached by a footbridge. The outfall works were also constructructed "in the dry" and the west bank of the Victoria Channel dredged to expose the cascaded flume which dissipates energy and so reduces the velocity of the outgoing circulating-water to the stipulated Harbour Commissioners' requirements of 0.75 knot. The remainder of the works consists of a valve house and concrete syphons to assist the pump discharge at low tide.

The main building comprises the turbine house, 570 ft. × 88 ft. (max.), and the boiler house 674 ft. × 99 ft., both of steel-framed construction but with no dividing-wall, and erected on a concrete foundation and super-structure blocks. The superstructure stanchions are positioned on pile caps, and have a box-shaped section which provides a smooth projection-free surface of pleasing appearance.



Sectional outline arrangement of one of the six boilers supplied by Mitchell Engineering Limited. These boilers have an evaporative capacity of 220,000 lb./hr. at a pressure of 950 lb./sq. in. and temperature of 925 deg. F.

The circulating-water pump-house accommodates three 23,000 g.p.m. and three 40,000 g.p.m. vertical-spindle centrifugal pumps, supplied by Gwynnes Pumps Ltd., and by Sigmund Pumps Ltd., which discharge into a bus pipe and so can readily be run up or shut down to suit the cooling-water requirements of the turbine house and ancillary plant which, at full load are 168,900 g.p.m. The pumping capacity is therefore just about sufficient to meet this demand with one large pump out of commission. Before entering the pumps, the water passes through band-type screens, each of which can be isolated for maintenance by a motor-operated penstock. The circulating-water is continuously chlorinated, the injection point being at the intake in the Herdman Channel, while slug injection is carried out at the inlets of condensers, oil and air-coolers. The whole of the circulating-water system is therefore safeguarded against mussel breeding and marine growth, and so far, the comparatively low chlorine rate of one part per million has been sufficient to keep the culverts clean.

Coal-handling plant

The coal consumption in the first section of the station is about 500 tons per day, but the total consumption by the 13 boilers in the completed station is approximately 2,000 tons per day, or 600,000 tons per annum. The

complete coal-handling plant was designed and supplied by Mitchell Engineering Limited. All coal supplies are seaborne, and to deal with them, a special wharf was constructed by the Belfast Harbour Commissioners on the east bank of the Herdman Channel. Erected on the wharf are four unloading cranes (supplied by Clyde Crane & Engineering Co.), each of 150 tons/hr. handling capacity, which feed into a hopper, integral with the crane structure. From the hopper, a conveyor transfers the coal to either of two wharf conveyors, each of which can handle 300 tons/hr.

The coal-handling plant conveys the coal (a) direct from wharf to the boiler bunkers or storage area; (b) from wharf to bunkers or storage area via crushers; or (c) from the storage area to the bunkers using either transporters or bulldozers. The transporter has a span of 200 ft. over an area which can accommodate about 50,000 tons, and can reclaim from stock at the rate of 300 tons/hr. The drive units for some of the Mitchell Engineering conveyors include squirrel-cage motors of 20 h.p. running at 730 r.p.m., with Vulcan-Sinclair size 20 traction-type fluid couplings. For other conveyors the motors are rated at 15 h.p. and run at 720 r.p.m., with size 17.75 fluid couplings—all these couplings being supplied by Fluidrive Engineering Co. Ltd. All the motors driving the coal-handling plant were supplied by Lancashire Dynamo & Crypto Limited.

Ash and dust-handling plant

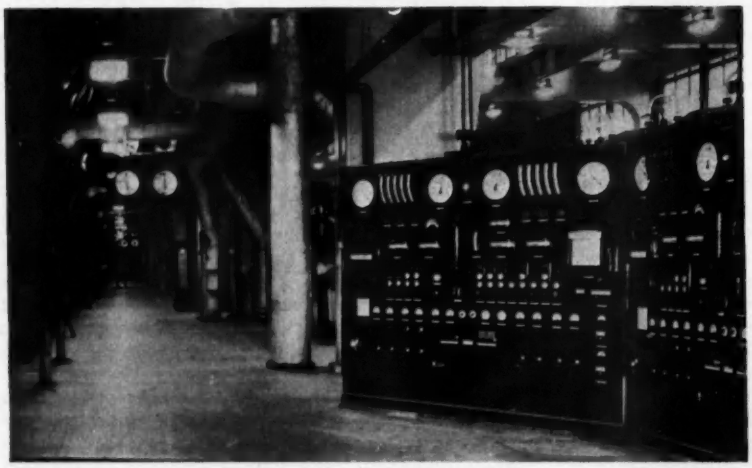
The ash and dust-handling plant was supplied by John Thompson Industrial Constructions Limited. Due to the fact that the 13 boilers were to be arranged in line, and in one boiler house, it was decided to instal a high-pressure sluicing system—the ash being removed hydraulically from storage-hoppers along the sluiceways at a rate of 40 tons/hr., passed through crushers, and then pumped into elevated concrete bunkers from which, after a draining period, the ash is discharged into lorries for removal from the site.

The dust and grit which are extracted from the flue-gases, and the fine-ash and riddlings from the chain-grate stokers, are stored in local steel-hoppers pending removal by the dust-handling plant. This plant, which is adjacent to the ash plant, consists of three eight-stage turbine exhausters each of which is capable of providing means for the conveyance of 7 tons/hr. of dust which is conveyed through pipes to storage-hoppers each having a capacity of 60 tons. As the dust is removed from these hoppers for cartage from the site, it is water-sprayed in a mixer-conveyor while being discharged into the trucks. The dust plant also provides facilities for surface cleaning, four vacuum hoses being able to work simultaneously to remove any dust which has accumulated on the boiler plant.

Boiler plant

The boiler plant in the initial installation was supplied by Clarke, Chapman & Co. Ltd. and consists of four units each of 180,000 lb./hr. capacity, and operating at a pressure of 650 lb./sq. in. and a final temperature of 925 deg. F. Each boiler is of the tri-drum type having two upper steam and water-drums and one lower water-drum interconnected by weldless-steel tubes. Extensions of the boiler plant consist of three units supplied by Babcock & Wilcox Limited and six supplied by Mitchell Engineering Limited. All have a continuous maximum output of 220,000 lb./hr. at a pressure of 950 lb./sq. in. at a temperature of 925 deg. F. The Mitchell boilers have an upper and lower drum, while the Babcock boilers have a single drum, with a compensating increase in superheater and economiser area. All 13 boilers are fitted with Babcock "Style-28" stokers, those for the initial installation being 32 ft. wide × 20 ft. long, and for the extensions 33 ft. wide × 22 ft. long.

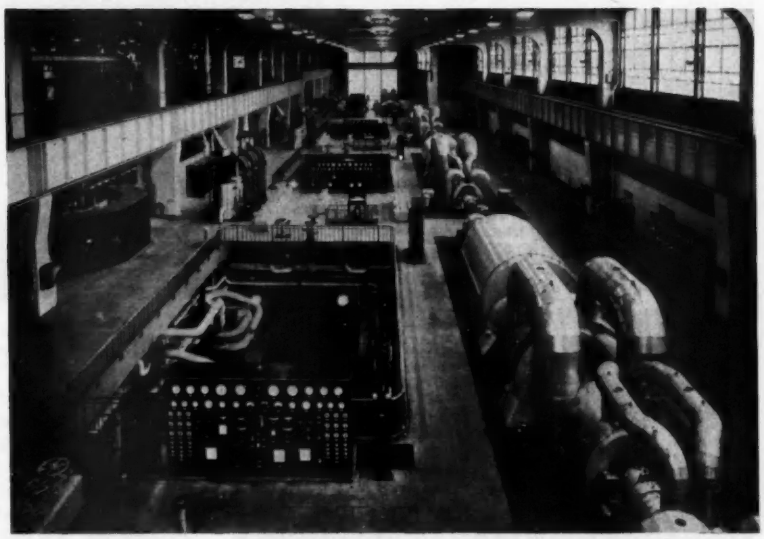
The automatically-controlled MeLeSco superheater on each of the Mitchell boilers (Nos. 8-13) was designed and manufactured by the Superheater Co. Ltd., to give a final steam temperature of 925 deg. F. at 950 lb./sq. in. over the range 154,000/220,000 lb./hr. The superheater comprises primary and secondary sections—the two-stage primary superheater having an effective surface of 5,910 sq. ft., is of the horizontal self-draining type, and is located in the second gas path of the boiler; the secondary section with 2,420 sq. ft. of effective surface, is of the pendant type and is located at the furnace outlet. The saturated steam passes from the rear drum into the primary inlet header situated below the first-stage, the saturated connecting tubes acting as steam cooled supports for this section. The steam passes upwards through the first and second contra-flow stages of the primary superheater to the secondary superheater inlet header and thence in parallel flow through the pendant secondary superheater to the final outlet header; thus the tubes of higher temperature are not located in a position of maximum gas temperature. The superheated steam at final conditions of temperature and pressure leaves the final outlet header by way of connections at each end. The final steam temperature is measured at



Boiler house firing aisle showing (on right) one of the boiler instrument panels supplied by Geo. Kent & Co. Ltd., and (on left) the fronts of the Babcock Style 28 stokers supplied for all 13 boilers.

the secondary superheater outlet and the resulting signals transmitted to a Kent "Mark 20" controller recorder. This instrument automatically controls the superheater by-pass damper such that the final steam temperature is maintained at the desired setting. A bias control is also incorporated to maintain steam temperature balance during periods when unbalanced gas conditions may exist.

The draught plant for the three Babcock boilers (Nos. 5-7) and for the six Mitchell boilers (Nos. 8-13) was arranged to be identical as regards duty. Two fans of each type—induced-draught, forced-draught and secondary-air—were supplied for each boiler, i.e. a total of 54 fans, all supplied by Musgrave & Co. Ltd., Belfast. The I.D. and F.D. fans are of the variable-speed type, and driven through hydraulic couplings; the secondary-air fans are of constant-speed type. The I.D. units each have a capacity of 53,500 cu. ft./min. at 290 deg. F. and 6.1 in. w.g. They are driven by 145 h.p. motors at 80 r.p.m. The F.D. fans each have a capacity of 34,800 cu. ft./min. at 100 deg. F. and 5 in. w.g. The driving motors are 65 h.p. at 730 r.p.m. The secondary-air fans are of 11,000 cu. ft./min. capacity at 300 deg. F. and 12½ in. w.g. They operate at a speed of 1,460 r.p.m., and are driven by motors of 35 h.p. All these fans are of the high efficiency aerofoil, backward-curved type. All the fan motors are supplied by Lancashire Dynamo and Crypto Limited. For each of the first four boilers (Nos. 1-4) which were supplied by Clarke Chapman & Co. Ltd., two Ljungstrom air-preheaters each of 7,080 sq. ft. heating surface were supplied by James Howden & Co. Ltd.; for each of the three Babcock boilers Howden's supplied two Ljungstrom preheaters each of 8,050 sq. ft. heating surface, and for each of the six Mitchell boilers, two air-preheaters each of 7,730 sq. ft. heating surface. These air-heaters reduce the temperature of the flue gases from 478 to 284 deg. F., while preheating the combustion air from 80 to 297 deg. F.



General view of the turbine house. In the foreground are the three 60-MW turbo-alternators with the two 30-MW sets in the background. All of these sets were supplied by C. A. Parsons & Co. Ltd.

Incidentally, James Howden & Co. Ltd. supplied the complete draught plant, and also the dust collecting plant (two multivortex, size 12 in.), for each of the four Clarke, Chapman boiler units.

Chimneys

It is possible that the original decisions to limit the capacity of the station first to 30-MW and then to 60-MW influenced the responsible authorities in restricting the height of the chimneys to 120 ft., that is 1.3 times the height of the building, as against the usually accepted requirement of 2.5 times the building height. When, however, it was decided to increase the capacity of the station to 240-MW it became imperative that a relaxation of height limitations must be conceded, and permission was eventually given to erect chimneys having a height not exceeding 240 ft., i.e. 2.3 times the building height, so approaching the conventional requirement. The two 120 ft. chimneys serve the four initial boilers and are fabricated from mild-steel plates which are protected from the action of the flue-gases by a cement lining. They have a base diameter of 20 ft. and a top diameter of 12 ft. The two 240 ft. chimneys, built by Tileman & Co. Ltd., London, are of reinforced-concrete with an acid-resisting brick lining separated by an air space from the concrete shell, the minimum thickness of which is 16 in. One chimney serves four boilers and has a top internal diameter of 12 ft. while the other serves five boilers and has a top diameter of 13 ft. Both chimneys carry two sets of aircraft obstruction lights, positioned 10 ft. and 80 ft. respectively from the top.

Pipework

All low-pressure and high-pressure pipework was supplied and erected by Stewarts and Lloyds Ltd. The main steam pipework has been arranged to provide, at minimum cost, reasonable flexibility for operation and maintenance, and has been constructed in chrome molybdenum alloy, hot finish, with all joints except at a few primary points butt-welded. Prior to welding, the ends of the pipes were heated to a temperature of 400-600 deg. F. and after welding, the joints were stress-relieved at a temperature of 1,200-1,300 deg. F. for a period of at least 2 hr./in. of wall thickness. Some 500 joints had to be made and, to prove their soundness, all were subsequently examined by gamma-ray.

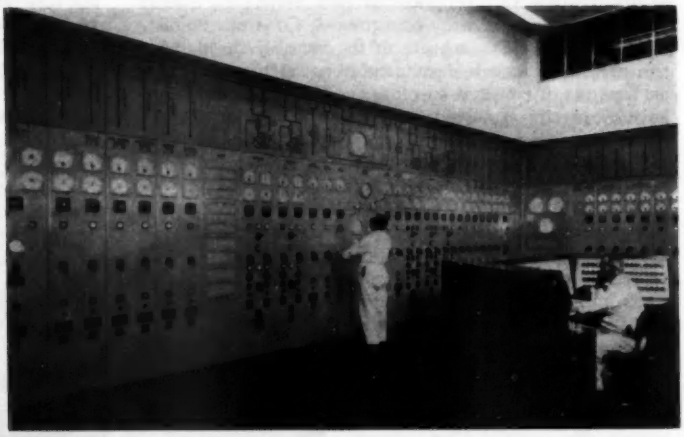
Turbo-alternator plant

The two 30-MW turbo-alternator sets in the initial installation, and the three 60-MW sets in the extensions are all of C. A. Parsons & Co. Ltd. design and manufacture, and all have an economic rating of 80 per cent. of the maximum continuous rating to suit the nature of the Northern Ireland load. All turbines are of the reaction type—the 30-MW machines being two-cylinder, and the 60-MW machines, three-cylinder units. All five machines

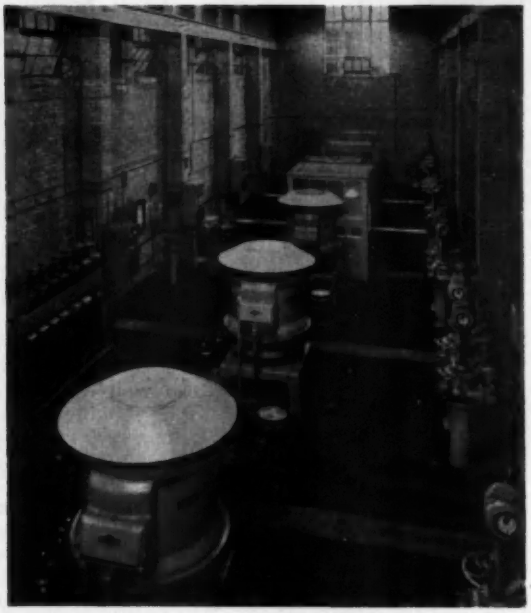
operate at 3,000 r.p.m.; the smaller machines which operate with steam conditions of 600 lb./sq. in., and 900 deg. F. have four stages of feed-heating, while the 60-MW machines operating at 900 lb./sq. in. and 900 deg. F. have five stages.

As these 60-MW sets are the largest in the country, and will consequently play an important part in meeting the Northern Ireland load for many years to come, they have been designed not only for maximum efficiency but also for reliability of a high order; and to contribute to this, very complete instrumentation has been provided,

(Right). Main station control room, which has a comprehensive telephone communication system enabling contact to be made with the various sections of the station, other stations on the system and principal sub-stations.



(Below). The circulating-water pump driving motors and valve-operating gear. There are three 23,000 g.p.m. and three 40,000 g.p.m. vertical-spindle centrifugal pumps supplied respectively by Gwynnes Pumps Ltd., and Sigmund Pumps Ltd.



together with turbovisory equipment for the indication and recording of shaft eccentricity and differential expansion. Such equipment is, of course, extremely useful when the machines run on a two-shift basis and are consequently shut down and run up at frequent intervals, conditions which are brought about by the nature of the system load.

Cooling of the 30-MW alternators is effected by means of a closed air circuit. Fans mounted in the foundation block and driven by independent motors, circulate air through a two-section water-cooler and into the alternator. The 60-MW generators are hydrogen-cooled in a completely-enclosed circuit which is gas-tight and designed to withstand an internal explosive pressure. The hydrogen is circulated through the stator, rotor and coolers by means of fans integral with the rotor. The stator ventilation circuit is arranged similarly to that of the 30-MW generators, and the cooler, in four sections, is in accordance with standard practice arranged longitudinally in the upper-half of the stator casing.

The boiler feed pumps were supplied by Sulzer Bros. (London) Limited. There are seven pumps, five of them being electrically-driven, and two steam-turbine-driven. All seven pumps are of size 32/20, and each has six stages. The capacity of each of the electrically-driven units is 630,000 lb./hr., the generating head being 1,220 lb./sq. in. g., the speed 2,975 r.p.m. and the temperature of the feed water 213 deg. F. The motors driving the pumps are of 1,275 b.h.p.—the electrical supply being 3·3 kV, 3-phase, 50 c/s. The two turbine-driven pumps are generally similar to the electrically-driven units, with the exception that the rated output is 650,000 lb./hr. and the speed 2,985 r.p.m. The steam turbines driving these two pumps are each of 1,300 h.p.

The 33-kV switchgear is housed in the switch house which is remote from the main station building, consisting of a central portion for the control room and offices, two wings with cellular compartments for the circuit breakers, a chamber for the duplicate busbars, and corridors for inspection and maintenance. All the 33-kV switch units were made and supplied by A. Reyrolle & Co. Ltd., and they have a rupturing capacity of 1,500-MVA. Each circuit-breaker is accommodated in its own compartment, the electrical connections being taken through the walls by specially-designed swivel bushings which, by operating in conjunction with contacts carried on fixed posts on either side of the walls, also provide the means of isolation.

This arrangement, a comprehensive system of interlocks and remote control of all the circuit-breakers from the main control room, together afford the maximum possible safety for the maintenance personnel and for the operation of the equipment. The circuit breakers are of the small

oil-volume type, and each is operated by means of a motor-charged spring-closing mechanism which is electrically-controlled from the main control room, although standby local control is available.

Control equipment (Boiler)

For the Babcock boilers (Nos. 5-7) and for the Mitchell boilers (Nos. 8-13), all nine sets of panels, instruments and automatic-control equipment were supplied by George Kent Limited, who also supplied complete instrumentation and controls for the first Clarke, Chapman boilers, (Nos. 1-4). Each boiler is provided with individual automatic-combustion and superheat-temperature control. For the Mitchell boilers, the Kent superheat-control instruments were supplied direct to the Superheater Co. Ltd. who incorporated these with their own equipment. Combustion control is based on the fuel/air ratio method with steam/air ratio trimming which automatically corrects for any variation in the calorific value of the coal being burned. Three Commander master pressure-controllers are installed, and normally each of these maintains constant steam pressure from three boilers but, by means of changeover valves, any one of the three instruments can control all nine boilers. On each boiler, the master pressure control signal passes to Kent power cylinders which regulate the forced-draught fan speed and also the position of the secondary-air dampers, The steam/air ratio controller already mentioned, works with an orifice plate in the steam line, and also receives a signal from an air-flow transmitter. The ratio-controller output resets the desired value of the fuel/air ratio controller which in turn regulates the position of Kent power cylinders connected to the stoker-motor induction regulators. Balanced-draught conditions are maintained by an F.A.F. Series sensitive furnace-pressure controller connected to the boiler combustion chamber. The signal from this instrument passes through an impulse relay to power cylinders regulating the speed of the induced-draught fans. Upon a load change causing the master pressure-controller to reposition the forced-draught and secondary-air regulators, an anticipatory signal is also fed to the above-mentioned impulse relay thereby instituting a preliminary movement of the induced-draught-fan regulator, which is finally positioned by the furnace pressure-controller. Superheat temperature is controlled by a thermocouple-operated Multelec controller which actuates power cylinders connected to the gas by-pass dampers. The boiler panels carry, in addition to the indicating, recording and controlling instruments, fan-control and electrically-operated-valve control stations as well as the remote damper-control equipment.

Control equipment (Electrical)

The control room has a comprehensive telephone communication system enabling contact to be made with the various sections of the station, with the control rooms of other power stations on the system, and with the principal sub-stations. The control panels, arranged around the walls accommodate the electrical equipment for the remote operation of the 33-kV switchgear, and the usual indicating instruments.

Behind the panels are cubicles containing the protective gear for the feeders and generators, an assembly of appliances which, in the event of an electrical disturbance, can initiate the necessary disconnection to clear the fault. In the centre of the room is the desk on which is duplicated certain manual and visual control equipment for the generators, and into which is built the telephone and message indicator equipment. All control panels and the protective gear were supplied and erected by A. Reyrolle & Co. Ltd.

At the opening ceremony at the station, Lord Brookeborough, the Prime Minister, said "There has been a staggering increase in the use of electricity in Northern Ireland since the war, and it is clear that the load demand is still far from its peak."

Alderman W. J. Lawther, chairman of Belfast Corporation Electricity Committee, said that the new power station was the fourth to be built by Belfast Corporation, and its completion comes six months after the opening, by H.R.H. Princess Royal, of the oil-fired power station at Coolkeeragh, Co. Londonderry, which will have an ultimate installed generating capacity of 360-MW.

The power stations in Northern Ireland's supply grid had, at the end of 1960, a capacity of 630-MW and maximum demand of 460-MW. Units sent out in 1960 exceeded 1,500 million. The careful long-term economic planning and positioning of the 110-kV grid system to meet prospective large consumers has been amply rewarded by the continually increasing loads that are being demanded along its route.

John Thompson Water Tube Boilers Limited have received an order for the supply of the boiler plant and its auxiliary equipment for the Lurgi Gasification Plant, which is to be installed by the West Midlands Gas Board at Coleshill, Warwickshire. The first of its type to be erected in England, the plant is intended to meet the increased demand for gas in the central industrial area within the confines of the West Midlands Gas Board area, and to utilise low-grade fuel for gas-production. The plant will eventually replace the Board's existing Mond Gas installation at Tipton, Staffs. Worth approximately £1 million, this important contract includes equipment manufactured by several companies within the John Thompson Group. The major items are two water-tube boilers, designed and manufactured by John Thompson Water-Tube Boilers Limited, this company being also responsible for the engineering of the complete contract. Each boiler will have an evaporative capacity of 125,000 lb./hr., one unit incorporating a re-heater and operating at a working pressure of 2,350 lb./sq. in. with a final steam temperature of 950 deg. F., the second boiler producing steam for process requirements at a pressure of 450 lb./sq. in., and final steam temperature 800 deg. F. The boilers will be pulverised-fuel-fired, the pulverising mills being of the Thompson-Kennedy type. The high-pressure and the low-pressure pipework in the boiler house and turbine house is to be manufactured by John Thompson Pipework Limited, and the complete water-treatment plant by John Thompson-Kennicott Limited, comprising filtration, deionisation and deaeration equipment. Vacuum-type ash and grit handling plant is to be supplied by John Thompson Induscon Limited. The first boiler is scheduled for steaming in March, 1963, with the second boiler in operation in autumn, 1963.

At the recent annual general meeting of the Thermal Insulation Contractors Association held at the Waldorf Hotel, London, **Mr. W. S. Isherwood** of Dicks Asbestos and Insulating Co. Ltd. was elected chairman and Mr. A. G. Brand of Cape Insulating and Asbestos Products Ltd., deputy chairman. At the same time the members present expressed to the immediate past chairman, Mr. G. H. Kenyon of William Kenyon and Sons Limited, and Mr. G. Alderson of Newalls Insulating Company their appreciation of the work they had done in the initial stages of the formation of the association.

Britain's first Lurgi Pressure-Gasification Plant

IN the December, 1959, issue of this journal, we published some details of the Lurgi pressure-gasification plant being installed by the Scottish Gas Board, at Westfield, near Kinglassie in Fifeshire, for producing gas from low-grade coal. The Westfield works are now in commission, and were officially opened by H.M. The Queen on Tuesday, June 27th. The plant, which has been built at a cost of £6,600,000 is the first of its type in Britain; and only the third in the English speaking world to incorporate the Lurgi process of high-pressure gasification. (The others are at Sasolburg in South Africa, and Morwell in Australia.)

The works is at present producing 15 million cu. ft./day of gas, but when the second stage of construction is completed a few months hence, this output will be doubled to 30 million cu. ft./day—an amount equivalent to one-fifth of the present total demand for gas in Scotland. Since the gas is made at high-pressure, it can be readily distributed over considerable distances. The Scottish Gas Board are therefore also constructing a high-pressure pipeline across Central Scotland which, when linked with existing grid-systems, will enable gas from Westfield to be distributed over an area of some 4,000 sq. miles. The estimated total cost of the works and high-pressure pipeline together is £8,500,000.

The Lurgi process is designed to make large quantities of gas from low-rank non-caking opencast coal which is totally unsuitable for gas-making by orthodox means. In effect, this means the development of a wholly new indigenous source of refined fuel. The plant at Westfield has been built adjacent to the workings of the Opencast Executive of the National Coal Board, where there are large deposits of low-rank coal contained within an area extending over about 270 acres. It has been estimated that more than 20 million tons of coal are contained within the comparatively small coaling area, and the depth of the excavation may ultimately reach 800 ft. The contract between the Scottish Gas Board and the National Coal Board provides for adequate supplies of coal to be made available to the works for a period of 20 years, or during the life of the opencast workings—whichever is the longest. A mixture of washed coal of size ½-1 in., to which a proportion of middlings (rejects of high-ash-content shale from the washery) has been added, is delivered to the works by railway wagon, and carried by conveyor belt to the gasifiers.

The Lurgi gasifier is a mild-steel vessel of fusion-welded construction, the main vessel being approximately 19 ft. overall height, with an outer dia. of 10 ft. The coal enters through a lock-hopper attached to the top of the gasifier; steam and oxygen at high-pressure are introduced at the lower end, and the gas is generated as a result of the reaction of steam and oxygen with the coal, at a pressure of about 30 atmospheres. Each gasifier produces upwards of 7½ million cu. ft./day of gas. Normally, with the present output of the works, two are in use, with one as a stand-by unit.

The three gasifiers first installed at Westfield were all made in Germany. The second-stage of construction provides for the installation of a fourth gasifier; and as the result of an agreement made between Humphreys and Glasgow Limited (who are the main contractors for the project), the Power Gas Corporation Limited and the Lurgi Company, this fourth unit will be made in Britain. It will be the first of its kind to be fabricated outside Germany. Since the Westfield works is unique, the plant incorporates a number of new features which, in addition to the gasifiers, have never before been operated

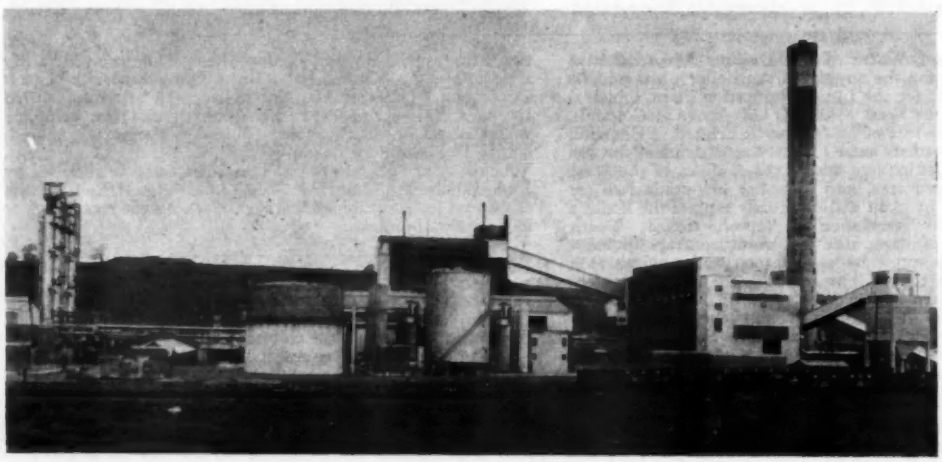


Fig. 1. View of Westfield Works looking from the south, showing (left to right), part of workshops, Benfield towers, oxygen plant with Lurgi house behind, boiler house, ash and coal conveyors.

in Britain. The commissioning of the plant was carried out in a surprisingly short space of time; coal was fed to the gasifiers on December 22nd, 1960, and gas was first fed to the distribution grid five days later.

One of the outstanding advantages of the Lurgi technique is that gas is produced at such high pressure that it can be readily distributed through pipelines over long distances without using compressors along the route. The pipeline for carrying the gas from Westfield to local grid systems around Glasgow in the west, and Perth and Dundee in the north, is designed for a maximum working pressure of 300 lb./sq. in. Already the pipeline, extending almost 75 miles, has been laid—linking Coatbridge and Newport to Westfield. The national supergrid as at present contemplated, comprises some 260 miles of steel high-pressure pipeline, ranging in size from 12 in. to 2 in. dia.

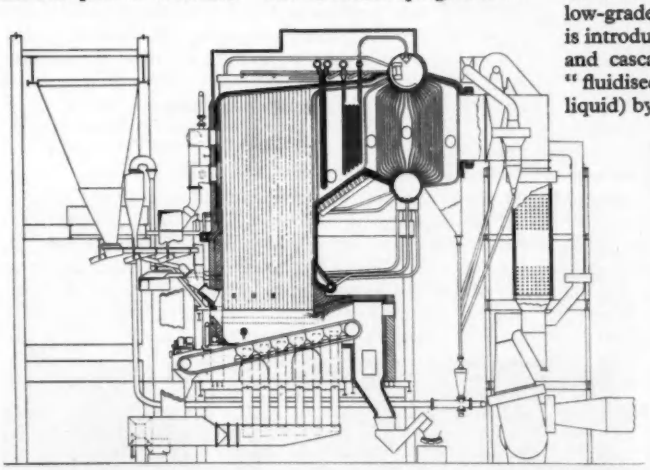


Fig. 2 (left). Sectional outline arrangement of one of the 45,000 lb./hr. Babcock Bi-drum boilers, equipped with Ignafluid firing equipment.

In the gasifiers, the gasification process is carried out in a stream of steam and oxygen at a pressure of 355 lb./sq. in. From the gasifiers, the gas, after cooling in order to remove tar and ammonia, is (still under high pressure) passed to oil-washers for the removal of benzole. It then passes to a "Benfield" plant where it is washed with hot potassium carbonate for the removal of most of the hydrogen sulphide and carbon dioxide. Provision is made for the re-cycling of tar to the top of the fuel-bed for the purpose of reducing the "carry over" of dust. Final removal of hydrogen sulphide to statutory requirements takes place in oxide towers, after which butane is admitted to enrich the calorific value to the statutory figure of 450 B.Th.U./cu. ft. The gas is then "refrigerated" to 4 deg. C. to remove water vapour before it passes into the super grid main at pressures up to 250 lb./sq. in.

Steam production

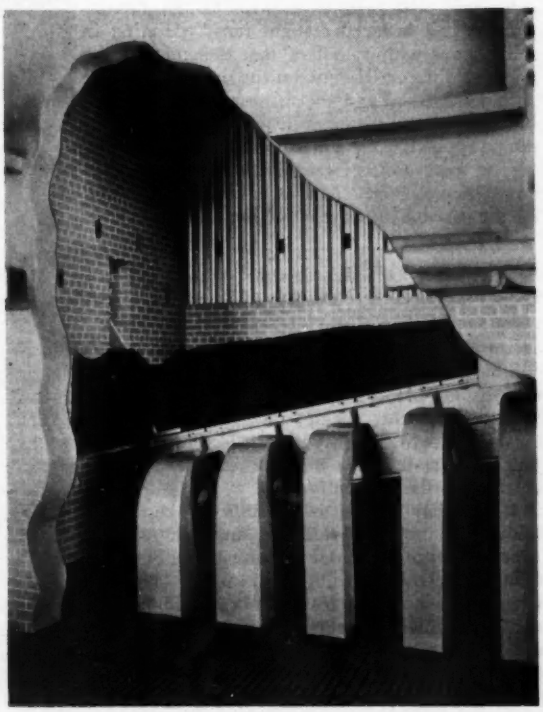
The steam supply to the gasifiers is provided by Babcock "Bi-drum" boilers each of 45,000 lb./hr. capacity—the steam supplied being at a pressure of 450 lb./sq. in., and a temperature of 730 deg. F. In the first stage of construction, two boilers have been installed.

The furnaces which are of new design and equipped with "Ignafluid" stokers, are intended to burn coal having a particle size below $\frac{3}{8}$ in., with, preferably, a large proportion below $\frac{1}{8}$ in. This is the first application in Britain of this new method of firing which has been developed by Babcock & Wilcox Limited, and its French associates. As can be seen from the sectional outline arrangement (Fig. 2), these boilers have a generating bank of vertical water-tubes connecting the upper and lower drums which extend across the boiler, and the single-pass gas-flow covers the full width of the boiler tube-bank from front to rear.

The superheater is of the pendant type, forming an integral part of the boiler, and is screened from furnace radiation by a row of water-tubes across the furnace exit.

"Ignafluid" firing is a modern method providing an effective solution to the problem of burning very fine, low-grade fuels, smokelessly and efficiently. The fine coal is introduced into the boiler furnace by a vibratory feeder, and cascades on to a fuel-bed that is maintained in a "fluidised" condition (the effect being that of a boiling liquid) by pulsated air streams injected below the narrow,

Fig. 3 (below). Cut-away view of model of Babcock Ignafluid boiler, showing inclined grate, ducting for pulsating primary air supply, sloping fuel banks, fuel feed and secondary-air ports.



chain-grate. This grate, which is inclined upwards towards the rear of the furnace and which travels from front to rear at a relatively high speed, should be regarded only as an ash carrier. Some of the fuel is burned in suspension, the remainder burning on the sloping sides of the fuel-bed between the boiler side-walls and the grate. The semi-molten ash flows by gravity down these sloping sides to the bottom of the fuel-bed, and by means of the chain-grate is conveyed as clinker to the rear of the furnace, where it is discharged to a suitable ash-removal plant.

Primary air from the forced-draught fan is fed to compartments below the upper strand of the grate, through divided trunking. The compartments are equipped with dampers providing for a decreasing air-pressure gradient from front to rear of the stoker. By means of a motor-driven " pulsator," or rotary disc-valve in the forced-draught fan outlet, the primary-air flow through the grate can be pulsated to produce continuous " fluidisation " of the fuel-bed, at variable frequency. This pulsation is to prevent segregation of the coarse and fine fuel particles (so improving combustion) and the agglomeration of clinker, and to extend the working range by assisting combustion at reduced boiler loadings. The secondary-air is introduced mainly through a series of nozzles along the front and sides of the furnace, well above the sloping fuel-banks and the fluidised fuel-bed, while a small amount of secondary-air is also passed under the rear arch on to the ash, to ensure that combustion is complete.

The boiler control equipment together with the instrument panels, was supplied by Bailey Meters and Controls Limited.

Control of this boiler plant at Westfield is semi-automatic, with manual control of the forced-draught and induced-draught fans, operating in conjunction with a system that depends on the pressure differential between the underside of the " fluidised " bed and the furnace above the bed. If required, fully-automatic combustion control can be applied, using a master-controller functioning on pressure or steam flow to control the forced-draught fan. Manual control is provided for the variable-speed drive to the chain grate, for adjustment of the rate of ash removal. In all systems where combustion of the fuel takes place partly or wholly in suspension, there can be a problem of " carry-over." With " Ignafluid " firing, this is suitably collected by means of high-efficiency grit-collectors, and re-fired by pneumatic re-injection into the furnace, through nozzles adjacent to the fuel entry.

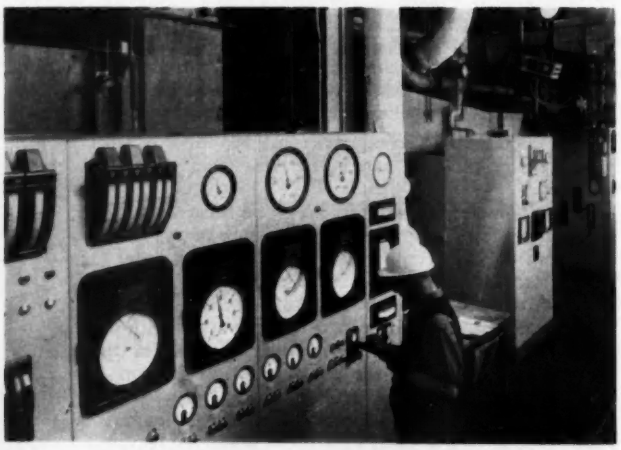


Fig. 4. One of the boiler instrument and control panels which were supplied by Bailey Meters and Controls Limited.

It is largely because of its ability to handle low-grade fines with very low riddlings and ash losses that the Ignafluid stoker can attain combustion efficiencies higher than are possible, using such fuels, on conventional chain-grate stokers. Furthermore, a higher CO_2 level can be maintained because there is no fire-bed, in the accepted sense, to give rise to unnecessarily high excess-air conditions.

The boiler feedwater treatment plant was supplied by the Permutit Co. Ltd. and comprises two Permutit Ion exchange water-softeners. These softeners are of the usual manually-operated DL type units that have come to be regarded as the standard softener for almost all general purposes. The DL softener consists of a steel pressure-vessel containing a bed of Ion exchange material supported on a layer of crushed flint termed Silex. A collecting system for the withdrawal of the softened water is embedded in the Silex. The water to be softened enters at the top of the vessel and is uniformly distributed over the Ion exchange bed. It then passes evenly downwards through the material and the hardness is removed by Ion exchange action. Externally, the plant has an assembly of stop-valves for controlling the regenerating sequence, and a meter is fitted to show the amount of water softened. A storage system for salt is also provided. The total flow of treated water from the two softener units is 24,000 gal./hr., and each unit will soften 500,000 gals. of raw water between regenerations.

Oxygen plant

Westfield is the first gasworks in Britain to use oxygen on a large scale for the production of town gas. The units installed are of the " Tonnox " type designed and constructed by the British Oxygen Co. Ltd., and are the first of their type to be installed in this country; they operate on the liquid-pump principle which, as the name implies, compresses oxygen in the liquid state and finally produces compressed gaseous oxygen as an integral feature of its design. The decision to install an oxygen plant of the liquid-pump type was reached because this type provides the necessary facilities for adequate storage of liquid oxygen. The system adopted provides sufficient capacity to hold 560 tons of liquid oxygen in storage. The liquid oxygen fraction is continuously withdrawn and compressed whilst still in the liquid state, to a pressure of 426 lb./sq. in., in a pump of Byron-Jackson design, operating at the temperature of liquid oxygen, namely 183 deg. C. Vaporisation of the liquid oxygen takes place in a heat-exchanger, after which it is pre-heated and passed to the Lurgi gasifier as gaseous oxygen at the required pressure of 426 lb./sq. in. This is the first time liquid oxygen pumps have been used for the Lurgi gasification process; all other plants have used gaseous oxygen compressors for this purpose.

Cooling and purification

Following the production of gas by the mixture in the gasifiers of the coal, steam and oxygen, the next stages are those of cooling and purification.

Crude gas leaves the gasifiers at a temperature of between 400 and 450 deg. C. Tar-water is sprayed into the gas in a quench cooler, and its temperature is reduced to about 196 deg. C. This allows the fullest use to be made of the latent heat of the gas as it passes through the waste-heat boilers; considerable quantities of low-pressure steam being obtained and used as process steam in the purification plant. The gas passes from the waste-heat boilers to a pre-cooler and from thence, in twin streams, to another installation of coolers, each stream of which consists of two vertical tubular water-cooled heat-exchangers in series, called respectively the "after-cooler" and the "final-cooler." After the Lurgi gas leaves the coolers it passes through various stages of purification, benzole being removed by washing with light oil. A further stage is the removal of carbon dioxide and hydrogen sulphide. This process may be carried out in one plant or in separate plants. The method adopted at Westfield is the hot potassium carbonate process in which the simultaneous removal of carbon-dioxide and hydrogen-sulphide takes place. This is done in the "Benfield" plant. The carbon-dioxide content of the Lurgi gas when it leaves the coolers is approximately 27 per cent.; and the hydrogen-sulphide content about 0.8 per cent. The high carbon-dioxide content must be reduced in view of its effect on the calorific value of the gas.

Essentially, the "Benfield" process involves the absorption of carbon-dioxide and hydrogen-sulphide in a 35 per cent. solution of potassium carbonate at high-pressure and at a temperature of approximately 110 deg. C. The carbon-dioxide and hydrogen-sulphide react with

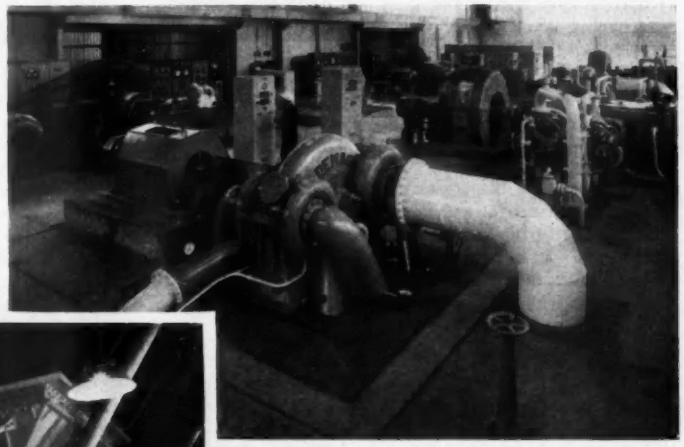


Fig. 5 (right). Oxygen plant compressor house showing air and nitrogen compressors, etc., for the two plants, which have a combined daily output of 200 tons of oxygen.

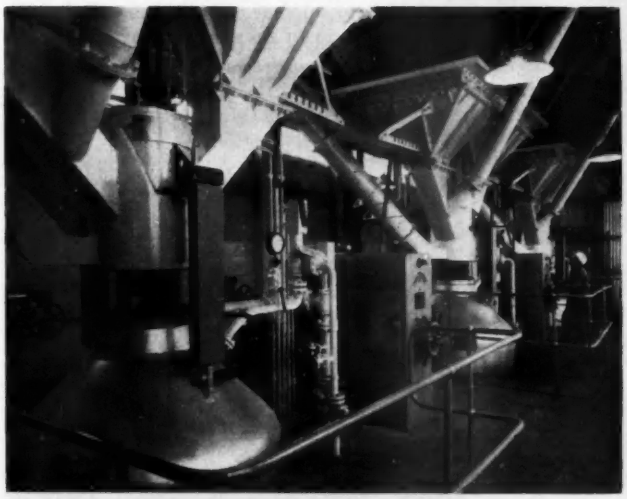


Fig. 6 (left). Lurgi house interior showing the gasifiers at coal-lock level. Each gasifier consumes 240 tons of coal, 60 tons of oxygen and 220 tons of steam per day to produce the equivalent of 7½ million cu. ft. of gas.

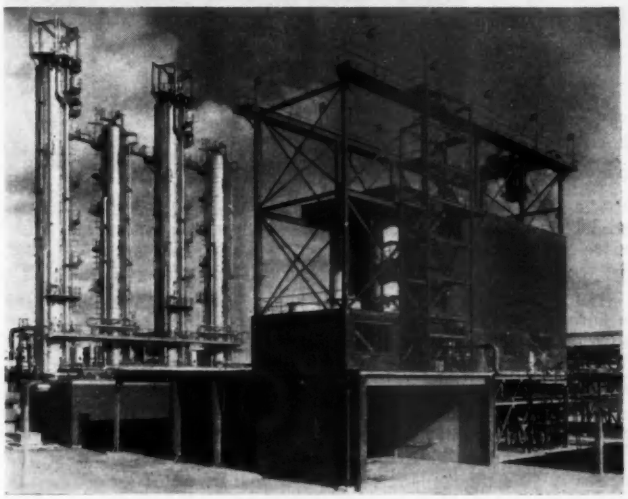


Fig. 7 (below). In the foreground is shown the final purification plant supplied by Newton Chambers & Co. Ltd. The Benfield towers can be seen in the background.

the potassium-carbonate to form potassium-bicarbonate and potassium-bisulphide respectively ; the solution leaves the absorber and, after a reduction of pressure from 325 to 5 lb./sq. in., passes to a regenerator vessel where conventional steam stripping is carried out at the same temperature.

The acid gases (or waste gases) leaving the top of the regenerator consist of approximately 98 per cent. of carbon-dioxide and 2 per cent. of hydrogen sulphide. After being cooled, they pass to a catalytic conversion plant where all hydrogen-sulphide is oxidised to sulphuric-dioxide. The waste gases are then mixed with boiler flue-gases, and finally pass to the main chimney. Plant for the recovery of sulphur from the waste gases will be installed during the second-stage of the construction of the works. The " Benfield " plant has been designed to give an absorption efficiency of carbon-dioxide and hydrogen-sulphide of over 90 per cent. In order to purify the gas to statutory requirements, it is necessary to add a further stage of purification before the gas passes into the grid main.

Four purifying towers, two for benzole recovery and two for the regeneration of the hot potassium-carbonate used to remove the carbon-dioxide and hydrogen-sulphide from the gas, were supplied by the Special Vessels Division of Babcock & Wilcox Ltd. The regenerator pressure-vessels are approximately 120 ft. high × 10 ft. 9 in. dia. The vessels were manufactured in halves, the bottom half weighing about 40 tons, and the top half, 30 tons. The two halves were welded together on site ; the shell thicknesses being from $\frac{1}{2}$ in. to $\frac{3}{4}$ in. in the ten individual ring sections. The two benzole absorbers (or towers) are each 45 ft. high × 3 ft. 6 in. internal dia., with a shell thickness of $\frac{13}{16}$ in., and designed for a pressure of 384 lb./sq. in.

The " Bischoff " system of oxide purification has been chosen for the final stages of hydrogen-sulphide removal. In this system, the gas passes through two streams, each of four towers designed for operation at a pressure of 340 lb./sq. in.; each purifier tower and one of two stacking towers is provided with 12 trays containing hydrated iron-oxide. Normally, both streams will be in action. When it becomes necessary to renew the oxide of iron purifying material, one stream is completely shut off, leaving the other stream temporarily to carry the full load.

The new type of tower purifier installation was supplied by Newton Chambers & Co. Ltd., Thorncliffe, near Sheffield. The purifiers (of the Bischoff design) have a capacity of 30 million cu. ft./day of gas. The Bischoff system eliminates the large number of valves usually associated with oxide purification, and oxide handling is fully-mechanised to reduce labour requirements.

The ammonia liquor concentration unit was also supplied by Newton Chambers & Co. Ltd. The ammoniacal liquor produced as a by-product during the Lurgi gasification process may contain up to 2·5 per cent. ammonia, which is practically all in the " free " state as ammonium-sulphide and ammonium-carbonate with only traces of thiosulphate, thiocyanate and chloride. The ammonia liquor is produced at the rate of 32,000 gal./day, and the plant concentrates this crude liquor to a product containing 24 per cent. ammonia.

The gas, which has been produced and purified by the processes described, requires to be " conditioned " so that its calorific value and specific gravity correspond to district requirements. The purified Lurgi gas has a calorific value of 400 B.Th.U./cu. ft. At present, the gas is enriched to 450 B.Th.U. by the addition of butane, supplies of which are brought in by road from Grangemouth Oil Refinery, some 35 miles from Westfield.

One of the problems that had to be solved at the Westfield plant was the daily disposal of more than 10

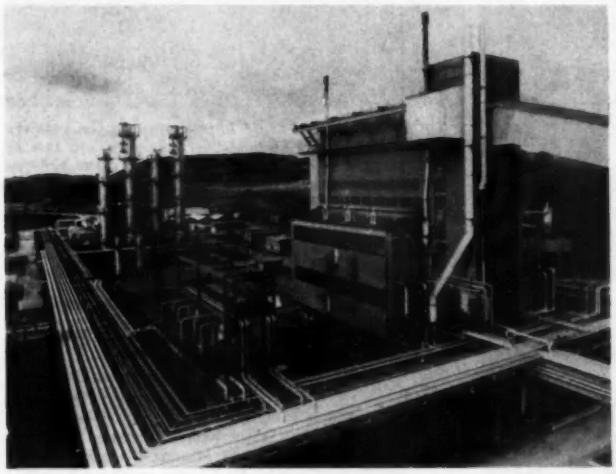


Fig. 8 (above). Pipe bridge, Lurgi house and Benfield towers, seen from the boiler house.

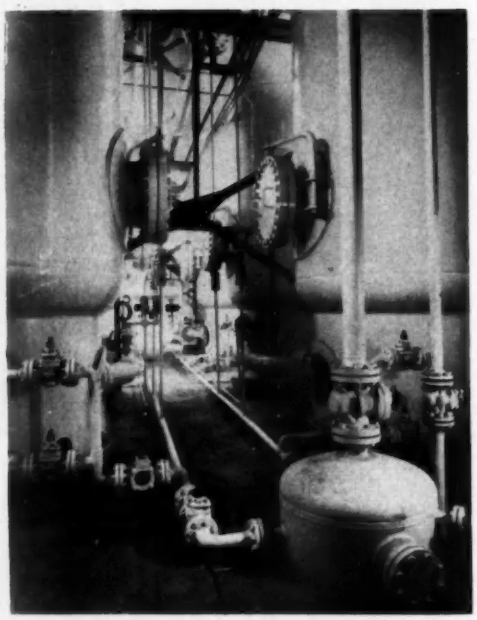


Fig. 9 (right). Final purification plant showing the towers, gas mains and condensate drainage system, all supplied by Newton Chambers & Co. Ltd.

million cu. ft. of waste acid gases. Catalytic oxidation of the hydrogen-sulphide to sulphur-dioxide before it mixes with the flue gases was selected as the most suitable process, and the contract for the design and construction of the waste gas disposal plant was awarded to Simon-Carves Limited. During operation of the first-stage of gas production, Simon-Carves are building a pilot-scale sulphur recovery plant to prove the practicability of installing a full-scale plant to operate when the second-stage of production is attained. The end product of the recovery plant is elemental sulphur, and the operating costs of the process are claimed to be the lowest of all the methods considered. All the equipment in the present gas-disposal plant will be incorporated in the final sulphur recovery installation.

The whole plant at Westfield is perhaps somewhat revolutionary in its requirements for automatic control equipment during production, and the gas-regulating valves in the high pressure "Supergrid" distribution system. The automatic control valves and liquid-level controllers in the process plant are generally similar to types used in oil refineries, chemical plants, and other process industries. Pneumatically-operated, the valves respond to a 3-15 lb./sq. in. signal from an automatic controller. The level controllers are used in conjunction with a control valve to maintain specified levels in process vessels independently of changes in flow rate. Both valves and level controllers have been supplied by the Fisher Governor Co. Ltd., a member of the Elliott-Automation group, who have also provided the distribution grid control equipment, which is completely new to this country, in that the valves are operated by the pressure of the gas in the system, not by compressed-air as in the Lurgi plant itself. By-pass systems are incorporated in the grid, and it also has release stations to provide a back-pressure or relief system preventing excess pressure in the pipelines. Another Elliott-Automation group company—Elliott Bros. (London) Limited—have installed the complete instrumentation system for the transmission of data on inlet-pressure, outlet-pressure and rates of flow at the 10 governor stations which control gas-flow from the supergrid to the local distribution holder stations. Information is transmitted to the Westfield plant where the central control room contains recording instruments, alarm indicators and flow integrators. The receiver panel has been designed with each bank relating to one station, plugged into a central 3 in. trunking, which runs the length of the control room and is completely wired and fitted with station sockets. Further stations can be added to the panel as they become operational, simply by removing the blanking plates on the panel face, fitting receivers, and connecting the appropriate leads. Other important ancillary plant at Westfield includes Simplex Mono recorders supplied by James Gordon and Co. Ltd. for the analysis and recording of carbon-dioxide, and a new type of final gas meter made by Sturtevant Engineering Co. Ltd., which gives equally accurate metering in either high or low pressure lines.

Further developments

As has been pointed out, the Westfield works is being constructed in two stages. During the second stage, which is now in progress, the fourth Lurgi gasifier will be installed together with a newly-developed plant for the reduction of carbon monoxide content of the gas. A further Babcock boiler with an "Ignafluid" stoker and also a sulphur-recovery plant for the removal of sulphur from the waste gases will also be introduced. The principal effect of these further developments will be that the total production of gas will be doubled. The effect of the carbon-monoxide conversion plant will be to reduce the carbon-monoxide content of the gas to less than 8 per cent.; it will also help to reduce the specific gravity of the final gas. The carbon-monoxide conversion plant will be installed at the outlet of the waste-heat boiler, and will treat hot crude Lurgi gas at a temperature of approximately 105 deg. C. This will be the first "raw gas conversion plant" to be installed outside Germany.

PRINTED CIRCUITS AND NAMEPLATE PRODUCTION

By courtesy of the directors of Printed Circuits Limited (an associated company of Associated Electrical Industries Ltd.), we were recently invited to visit their works at Boreham Wood, Herts, to see some of the advances which have been made there for the production of high-quality printed circuits of all descriptions. Printed Circuits Ltd., in association with Millett, Levens (Engravers) Limited, now have a large and modern works specificially designed and laid out for the production of these printed circuits, and for industrial name-plates and instrument panels. The works are equipped with two revolutionary and completely automatic machines for etching and anodising. The demand for high-quality printed circuits, etc., has increased very considerably during the last few years, and the company has now completed the reorganisation of their manufacturing resources—designed to provide the most comprehensive service to industry. The new plant, which is electronically controlled, is the result of nearly two years' research and development and is believed to be unique. Manual handling during processing is eliminated, and both the time-cycling and chemical contents of the processing tanks are rigidly controlled to ensure a high and absolutely consistent standard of work. Both the etching and anodising machines incorporate a full cleansing and degreasing operation before and after processing. The processing tanks are metered as necessary, and the information fed back into the control circuit to render the whole process automatic. Processing information is also displayed visually on a bank of pH meters, beaume meters, temperature indicators, time clocks, etc. The equipment provides for automatic selection of any one of a number of dyes which are constantly available to their correct specification, together with the fixing and sealing processes to ensure a continuity of colours throughout a long production run. Designed primarily for the rapid etching of printed circuits, the etching unit is capable of handling single- and double-sided boards of various laminates and thicknesses. Controlled withdrawal from the etchant is also possible, providing chemical milling facilities. Ancillary equipment includes off-set litho and silk screen printing machines, process cameras and electronic step and repeat cameras, automatic infra-red waterwash spraybooth for protective and flux lacquering treatments, infra-red heated blanking tools and presses. The company has also built what is claimed to be one of the finest dust-free controlled atmosphere laboratories and production units in the country. This unit is self-contained and fully-equipped, and its facilities are available to all sections of industry engaged in the development or production of micro miniature and solid state electronic devices. The etching and anodising installations complete a phase of the reorganisation which has brought a variety of new and modern equipment into use. The equipment comprises an exposure head which moves automatically along and across the area of the multiple master negative in steps which are preset according to the size of the design and the number of exposures which can be accommodated in the master negative area of 25 sq. ft. For photo litho reproduction, the master is printed photographically on to a zinc plate which has been coated

with light-sensitive emulsion. Following the development process, etching and fusing, the plate is placed in an off-set press as shown in Fig. 1, and the image is transferred to the copper laminate of the printed circuit board by the normal off-set process, but using a special ink resist. Two runs through the press are made where the design is such that large areas of copper have to be treated. The plate is then fused to make the printed portion fully acid resistant. Bitumen powder is spread on the board and packed in by infra-red heating. These preparations are claimed to safeguard fine lines in the diagram.

Fig. 1. Offset litho printing of circuits direct on to copper sheets with laminated insulate at the works of Printed Circuits Limited.

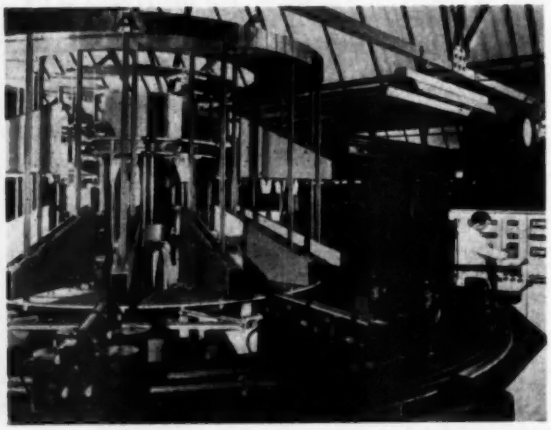


Fig. 2. Automatic etching equipment capable of producing upwards of 3,000 circuits per hour. The only machine of its kind in the world, and made to Printed Circuits design.

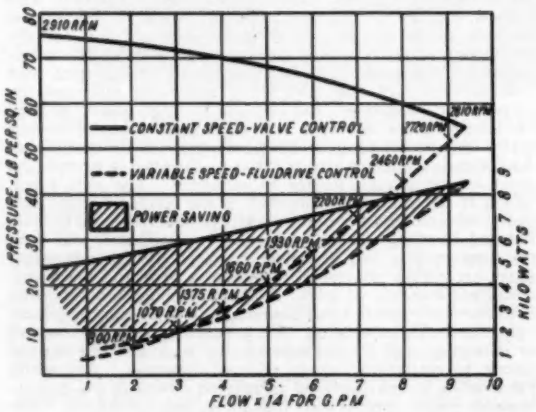
Recent developments by Printed Circuits Ltd., outside the range of conventional electronic circuitry, have included the production, by the techniques described above, of S-band waveguides, a printed circuit with copper conductors in "Perspex" and control system wiring for a boiler oil-firing unit. The company has also produced as a prototype, a d.c. motor armature in the form of a printed circuit on a disc of glass fibre material 0.03 in. thick. The circuit is printed on both sides of the disc, connections between the sides being made by plating through holes. There are 97 conductors, 0.004 in. thick, on each side, making an eight-pole, 97-turn wave winding. The conductors can be loaded up to 40 A/sq. mm. This experimental armature would be suitable for a servo motor of approximately 0.2 h.p., but it is expected that similar construction could be used for powers up to 2 h.p. at 3,000 r.p.m.

During our visit to the works, we were able to see the automatic anodising and dyeing plant fully-engaged in the production of the chemically-engraved and anodised industrial nameplates, instrument panels, escutcheons, etc., in which Millett, Levens (Engravers) Ltd. has specialised since the company was formed shortly after the war. A new product within the range of nameplates shown was "Magnoplate" consisting of nameplates on a p.v.c. base with a ferric powder backing, for temporary attachment to ferrour surfaces.

FLUID COUPLINGS FOR CONTROL OF CENTRIFUGAL PUMPS

The advantages of using a scoop-control fluid coupling to adjust the speed of output of a centrifugal pump, instead of running the pump at a constant-speed and throttling the discharge, were demonstrated in striking fashion by Fluidrive Engineering Co. Ltd. on their stand at the recently-held Engineering and Marine Exhibition at Olympia. For many years the conventional method of controlling the output from a centrifugal pump was to run it at constant speed, and effect regulation by means of a throttling valve. However, it is clear that this method of control involves considerable wastage in power, because of the pressure-drop created across the valve which may easily exceed the total requirements of the remainder of the system. Even at full throughput, a pressure-drop must be maintained across the valve in order to provide stable control up to the design point. In some systems, where heat-exchangers and suchlike are positioned between the pump discharge and the control valve, the high pressures encountered at reduced throughput can create a problem.

A much more efficient method of control is to run the pump at whatever speed is required to develop just sufficient head to overcome the system resistance for particular flow conditions. The required characteristics are inherent in a drive system consisting of a Vulcan-Sinclair scoop-control fluid coupling fitted between a squirrel-cage motor and a centrifugal pump. The coupling gives variable speed at the pump while retaining the simplicity, reliability and economy of the constant-speed squirrel-cage motor. In order to demonstrate the advantages of the system, Fluidrive Engineering Co. Ltd. designed and assembled a special rig consisting of a 10 h.p. 2,910 r.p.m. squirrel-cage motor (with direct-on-line starting) driving through a size-8 "SCR6" fluid coupling to control a Hayward Tyler—Bryon Jackson 2 × 3 × 8 H.S.M. process



Curves showing performance of variable-speed pump with "Fluidrive" coupling, compared with that of constant-speed pump with throttle control.

pump designed to discharge about 140 gal./min. against a head of 145 ft. Manual control is provided for the fluid coupling, and the pump speed is measured by a tachometer. A wattmeter indicates the power consumption of the motor. Water is discharged from the pump, through a 3-in. pipe fitted with a Foxboro indicating flowmeter and a pressure gauge to a 1½ in. pipe containing a throttle valve. The output side of the valve is connected to a length of p.v.c. pipe which simulates a system having some frictional resistance and discharges into a tank which is connected by pipe to the suction side of the pump. The following two methods of control can be efficiently and fully demonstrated with this arrangement of plant.

(1) *Constant speed pump with throttle control.* The pump is run at constant speed with the fluid coupling fully engaged, the flow being controlled as required by valve throttling. Values of hydraulic pressure and input power to the motor are observed over an appreciable range of flow conditions. Typical results can be seen from the accompanying curves.

(2) *Variable speed pump with scoop-control fluid coupling.* With the throttle valve fully-open, the pump speed is varied by adjustment of the control level of the fluid coupling. For the same range of flow conditions as in the first method, the pressures and motor inputs are observed, the results also being evident from the curves shown in the diagram.

Typical centrifugal pump applications where Fluidrive is used, are to be found in power station plant, e.g., boiler feed-pump, boiler water-circulating pump and ash-pump drives; in applications such as the oil, sugar and pulp and paper industries; in municipal undertakings, for district-heating pumps, water supply, sewage and drainage pumps, etc.; and for slime and slurry pumps in the mining industry.

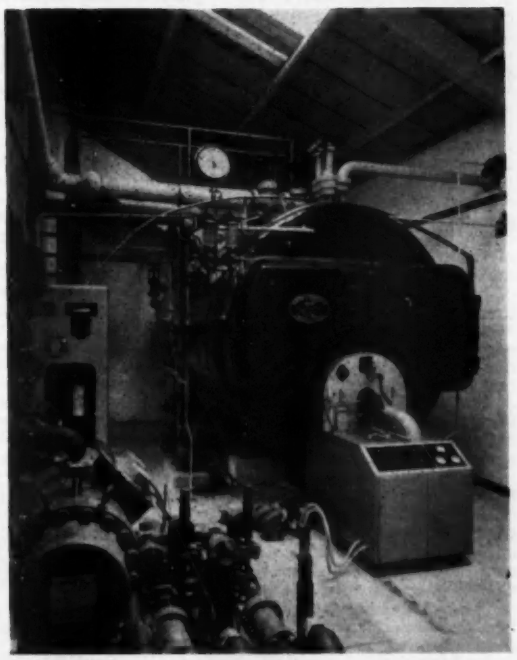
AUTOMATION IN LAUNDRY PLANT

WE recently had the opportunity of visiting what is claimed to be the first complete new linen-supply plant to be built in the United Kingdom for more than a quarter of a century, and where modern automatic machines enable two men to wash nearly one ton/hr. of dirty linen. The new plant, built for Spring Grove Laundries Limited, at Twickenham Road, Hanworth, has been designed solely for use on linen supply, contract and industrial laundry, and contains the most fully-automatic laundry equipment at present available, including washers and spin-driers served by the latest type of lifting equipment, and what is stated to be the biggest tumbler-drier in the world. To house equipment of this size and with such a high-speed output, it was necessary to devise a special building, to meet the unusual requirements. The design, which incorporates the use of some of the longest pre-stressed concrete beams in the country, has involved the use of the most up-to-date techniques in concrete engineering. Although the plant has only recently started operation, the demand for a linen hire service among hospitals, hotels and industrial organisations in the area is so great, that plans are already being made to more than double the capacity of the Hanworth plant at an early date. The first phase of the new laundry covers some 20,400 ft. of floor area. The contract for the structural frames, floors, staircases, roof-covering, patent glazing, insulation lining, to both north light and flat roofs, together with pile caps, ground beams and reconstructed stone on the front elevation was carried out by Orlit Limited, Egham. The site consisted chiefly of made-up ground, and 50-ton concrete piles were used to carry the loads down to between 20 ft. and 30 ft. through fill and sand, into stiff London clay. Spring Grove Laundries Limited, which was founded in the middle of the last century, has since its inception been developed from a purely domestic laundry to become one of the largest contract laundries in the country, with branches in the Midlands, the North, the West, and East Anglia, in addition to extensive operations in London. The company pioneered a linen-hire service for hospitals, hotels and industrial users in this country.

In 1945, Spring Grove put into operation one of the first wetwork conveyors for laundry use in the world. The highly automatic system in use at Hanworth marks a further step forward in laundry techniques. Spring Grove's linen-hire service began operation before the last war, and in recent years has expanded to become one of the largest of its type in the country.

Laundry equipment

The bulk of the washing and drying equipment at Hanworth is Swedish-made to an American design, by Calor of Stockholm under licence from the Ellis Drier Co. of Chicago. It has been selected for the Hanworth plant because it is the only fully-automatic equipment available on such a large scale of operation. The Hanworth layout comprises two 800 lb. dumping washers, with full automatic control; two 54-in. hydro-extractors, each having a capacity of 400 lb. dry-weight; one 72-in. 200-lb. dry-weight gas-fired tumbler-drier, said to be the largest in existence; and two flatwork ironers of four and six rollers, the larger being additionally equipped for "Rolomatic" towel ironing. The plant is augmented by one 50-lb. capacity washer, one 30-in. extractor, and three 30-lb. capacity tumbler-driers, for smaller loads. Transport of loads between the various processes is carried out by a 1-ton capacity travelling gantry crane by Clayton, of Liverpool. The dry-cleaning plant comprises two 100-lb. capacity "Spencer Senior" fully-automatic de-greasing units, together with an automatic "Adsorber" carbon-recovery unit. The plant has its own electricity sub-station (H/T) incorporated in the side annexe, while heating for the washing solutions, which are made up on the plant and automatically pumped into the washers, is obtained from a flash-steam vessel which recovers surplus heat from the condensate return system.



The 5,000 lb./hr. capacity "Thermax" type horizontal boiler installed at Spring Grove Laundry, Hanworth, by Ruston & Hornsby Limited, Lincoln.

Boiler plant

The process steam supply for the washing machines, and also the laundry space-heating requirements, are met by one of the latest "Thermax" type horizontal boilers, which was supplied by Ruston and Hornsby Limited, Lincoln. This boiler, which is fitted with an oil-burner of the fully-automatic and modulating type, is 12 ft. long × 7 ft. 6 in. dia. It is designed for an output capacity of 5,000 lb./hr. of steam when working at a pressure of 100 lb./sq. in. and a temperature

of 212 deg. F. The oil pumping and heating plant for the boiler was supplied by Associated British Combustion Limited, and is supplied from a 12,000 gallon capacity oil-storage tank. The instrument panel, which was supplied by Controls and Electronics Limited, Porchester, Hants., carries an Electroflo steam-flow chart recorder. The two boiler feed pumps were supplied by Worthington Simpson Limited, and water-level is controlled by Mobrey equipment supplied by Ronald Trist and Co. Ltd. An interesting feature of the boiler house is that it has been designed eventually to accommodate a further boiler unit, which will be a duplicate of the first one, and which will be brought into service when the laundry expansion scheme takes place. Provision has been made also, of course, for duplicating all the ancillary plant.

The Ruston horizontal type "Thermax" boiler was the first three-pass "wet-back" boiler to be produced in this country, and it is interesting to note that although this unit has been in production for a quarter of a century only minor modifications have been required to maintain its position in the field of efficient steam raising plant. The "Thermax" boiler is made in a wide range of sizes with evaporative capacities of 1,200 to 17,500 lb./hr. from feedwater from and at 212 deg. F. and for working pressures up to 200 lb./sq. in.

The building

As mentioned earlier, the unusual requirements of the equipment in use at the Hanworth plant dictated a building of special design. To allow for a very large open working area unobstructed by pillars, special foundations were designed to carry the weight and withstand the vibration of the powerful extractors and tumblers, and at the same time, to allow for works expansion. To provide the necessary working space, the contractors designed a structure incorporating some of the longest pre-stressed concrete beams fabricated in this country, each over 90 ft. in length. The first floor sorting area is cantilevered over the working space to house the special machinery. This also provides a necessary expansion joint between the buildings. The foundation is carried on 79 concrete piles of an average length of 39 ft., 32 of which are driven beneath the boiler house. While this section occupies only about one-sixteenth of the total 20,000 sq. ft. of floor area, it contains equipment weighing more than 200 tons. Work was started on the building in May, 1960, and was completed, including piling and sewer-laying, in an overall time of only nine months. The building was planned by Spring Grove Laundries Limited themselves, and designed and constructed by Grove Building (Hanworth) Limited, in collaboration with the main sub-contractor, Orlit Limited, of Egham (for the superstructure) and the consulting engineers, Messrs. S. H. & D. E. White, civil engineers, of Victoria Street, S.W.1 (for the foundations) together with the engineering department of Spring Grove Laundries Limited.

SPACE AGE STEAM

The purpose of a new colour film produced by J. Stone & Co. (Deptford) Ltd., and entitled "Space Age Steam," is to make available, to the widest possible cross-section of engineers, steam users and students, greater knowledge of Stone-Vapor boilers; the design principles, method of construction and test, and also typical applications in the United Kingdom. The original design work on the Stone-Vapor boiler was by an Englishman named Alec Clarkson who emigrated to the U.S.A. in the late twenties. He was then employed by the Vapor Heating Corporation of Chicago, and as a result of this collaboration, an exclusive and successful design of a water-tube boiler was evolved for use on the American railroads, where steam locomotives were being replaced by diesel locomotives in their modernisation programmes. The boilers were in most cases mounted in the locomotives and provided between 3,000 and 5,000 lb./hr. of steam for carriage heating at a delivery pressure of 230 lb./sq. in. In spite of intense competition from other U.S. boiler makers, the Vapor boiler has, for over 25 years, been used exclusively on the railroads of the U.S.A., Canada and Mexico. In later years large numbers have been supplied to most of the railroads in Europe and South Africa, etc., as the diesel locomotives replaced steam locomotives. More recently many hundreds have been supplied for the diesel locomotives of British Railways. It was natural that a boiler which would stand up to this extremely rough usage and, at the same time, be essentially safe when unsupervised, would meet a growing demand in industry which, for many years, had been forced to use massive boilers requiring much space, special boiler-houses, high chimneys and constant supervision by firemen. These conventional designs could also be highly dangerous due to the large mass of water contained, and the large combustion chambers. The basic principle of a once-through forced-circulation water-tube boiler is not new, but the Vapor Corporation succeeded in developing Alec Clarkson's designs to produce a thoroughly reliable unit of this type. A higher heat-release and steam output than ever before was achieved from a smaller size, and the boilers could be produced at a very competitive price. J. Stone & Co. (Deptford) Ltd. have enjoyed a long association with the Vapor Corporation, and in 1955 acquired the manufacturing licence for the Vapor boiler which now, in its British form, conforming to British Standards and Lloyd's requirements, is known as the Stone-Vapor boiler. At present more than 20,000 units are in use throughout the world in industrial, marine and railroad applications, and also in four major navies. A sufficient recommendation as to their essential safety is the fact that no explosion has ever been recorded. Whilst at first Stone's found it difficult to persuade British users that steam could be raised within two minutes from cold, in less than one-fifth the space normally occupied, there is now a growing acceptance of the boiler, resulting in a steady increase in production, which now stands at the rate of approximately 30 per month in Great Britain alone. The main claims for this type of boiler include: low capital and installation costs, space, labour and fuel savings, robust and safe construction, instant response, smokeless combustion and simple maintenance. Production centres around a design pressure of up to 300 lb./sq. in. in four main sizes, as follows:

Evaporation rate in lb. of steam per hour	*Boiler type number*
1,202	OK.4610
2,105	OK.4616
3,310	OK.4625
5,420	OK.4740

They are available for oil-firing and gas-firing, and in some cases a combination of both, thus enabling a quick changeover from one fuel to another if this is desired. Special models are available for pressures up to 1,000 lb./sq. in. as also are superheaters for steam temperatures up to 1,200 deg. F. The controls are so designed that larger outputs up to, say, 30,000 lb./hr. of steam can be provided by an appropriate number of units in a multiple installation, thus maintaining peak efficiency throughout a wide range of loads from light summer to heavy winter. Typical applications include: air-conditioning, asphalt plants, brewing and bottling, chemical plants, civil engineering, cleansing and de-gassing, dairies, dry-cleaning and dyeing, evaporators, factory heating, marine auxiliaries, metal finishing, mobile emergency steam raising, oilfields and terminals, space heating, "steam-for-sale" plant, testing (high pressure), works heating, etc. Applications for the loan of the film should be made direct to the Sales Department, J. Stone & Co. (Deptford) Ltd., London, S.E.14. (Arrangements can be made if necessary for an operator and projector in certain instances for group meetings.) The services of a Technical Engineer to answer questions will be made available in each case.

Bennis Combustion Ltd. have obtained the contract (valued at over £66,000) for the supply and installation of an ash-handling plant at Kearsley Power Station of the Central Electricity Generating Board (North West, Merseyside and North Wales Region). The plant, which will replace an old monorail bucket system, will quench and convey the ash from 16 water-tube boilers to a 350-ton capacity, reinforced-concrete bunker. The conveyor system comprises 25 belt-conveyors, of which eight are of the submerged type for quenching the hot ash. Riddlings from the boilers are collected on dry belt-conveyors, and join the quenched ash at a central point from where it is all taken by an inclined belt-conveyor to the bunker. The whole system is automatically controlled from a central panel, and it has a total capacity of 56 tons (dry ash)/hr. Installation is being so planned that it will not interfere in any way with the power station output, and it is intended to have the plant functional by the end of October this year.

RECENT Equipment AND Accessories

Paterson "BM" residual chlorine recorder

The "BM" residual chlorine recorder, which has just been produced by the Paterson Engineering Co. Ltd., operates on an entirely new principle for instruments of this type. This recorder has been developed to fulfil the need for a unit which is strongly built and accurate in operation, and yet requires very little maintenance. Operating on the bi-metallic cell principle, its design is said to be considerably less complicated than that of instruments using colorimetric measurement. It employs a small perspex constant-head chamber of orthodox overflow-type in which the sample water is received and measured. From this chamber the water gravitates through the instrument, so that only sufficient head to deliver the water to the chamber is required, thus in most instances, sampling pumps are not required. The incoming supply is controlled by a small valve manipulated from the front of the cabinet, where the flow is visible at all times. The water then passes to a larger mixing chamber, also of perspex, in which it is thoroughly mixed with a reagent by a swirling action. The reagent used is a simple buffer solution to which is added a small percentage of a specially-developed compound known as "BM 18" which prevents the formation of mould growth without affecting the chlorine residual. The solution is fed by gravity, on a constant-head principle, through special drip-valves, from a vessel having sufficient capacity for an eight-day supply. The reagent-treated sample-water then passes to the specially designed "BM" cell where the chlorine is measured by two electrodes, which produce current proportionately to the chlorine concentration. Two wire-wound drums with metallic brushes deliver the output from the electrodes, without the necessity of amplification, to an electronic indicator and recorder which incorporates a highly sensitive circuit. A circular chart, calibrated from 0 to 1 p.p.m., provides a seven-day record, and a sweeping pointer gives rapid visual indication on a large peripheral scale. In cases where a reading of the total chlorine, as well as the free chlorine, is required, a second reagent vessel is fitted and a solution of potassium iodide is used in addition. The "BM" residual chlorine recorder (Fig. 1) is housed in a reinforced glass-fibre cabinet occupying a floor area of 4 sq. ft. Installation is claimed to be simple, the only requirements, apart from the sample water supply, being a connection to the electrical supply, and access to a drain. (*The Paterson Engineering Co. Ltd.*, 129, *Kingsway, London, W.C.2.*)

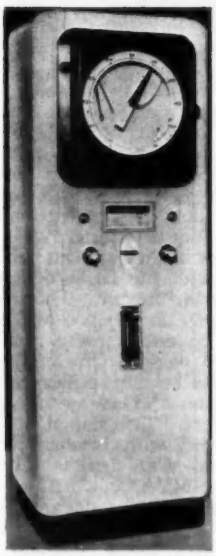


Fig. 1 (left). Paterson "BM" residual chlorine recorder (The Paterson Engineering Co. Ltd.).

New "constant weight" feeding system

A conventional "hopper-discharger," feeding say, a 40-tons/hr. capacity grinding-mill, has to be set so that its output never exceeds 40 tons/hr. in order to guard against the mill being overloaded. This means that, because the density of the material being handled varies by as much as 20 per cent., the hopper-discharger must be adjusted so that its average output is only 36 tons/hr. —4 tons/hr. less than the capacity of the mill. To eliminate this waste of capacity, a new feed control system (Fig. 2) has been developed by Richardson Scale Limited. This system, which uses a proportional action controller, frees the output from the effects of variations in bulk density. The controller continuously-adjusts a power-cylinder on the hopper discharger, to keep the feed constant in weight and equal to the maximum capacity of the mill. The proportional action controller, supplied by Honeywell Controls Limited, may be positioned up to 300 ft. away from the feeder; making it possible for a number of feeders to be controlled from a central control panel. The controllers are of the recording type and provide permanent records of actual performance, for routine checking, cost accounting, etc. The system can be supplied as a complete package that includes all instruments, driving motor, starter, etc.; alternatively, the control system only—feedrate-indicator, recording-controller, and power cylinder—can be supplied, for use with existing conveying systems. (*Honeywell Controls Limited, Greenford, Middlesex.*)

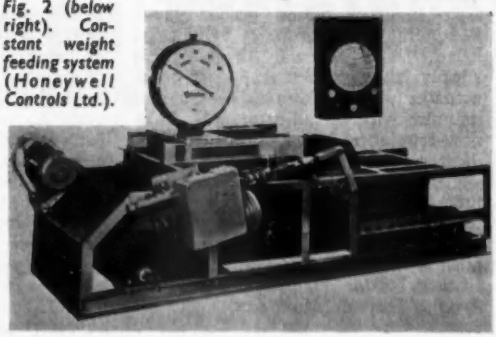


Fig. 2 (below right). Constant weight feeding system (Honeywell Controls Ltd.).

New pressure-recorder

Walker Crosweller recently announced that their wall-mounting "Arkon Model 60" pressure-recorder is now available. Of sturdy construction, the recorder (Fig. 3) is designed so that it can be driven by either a spring-wound clock or electric motor. The instrument uses an 8 in. dia. chart having 24-hour or 7-day rotation and is available for a wide variety of ranges

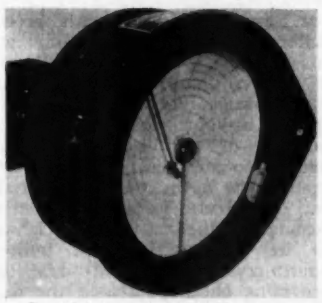


Fig. 3. "Arkon Model 60" pressure recorder (Walker, Crosweller & Co. Ltd.).

from 5 to 500 lb./sq. in. for the measurement of gas, air, steam, water, oil and similar liquids. The recorder has a dust and moisture-proof glazed door, fitted with an integral lock, and the chart record is visible at all times. A portable version is also available, which is fitted with handle and stand; its total weight being only 9½ lb. (*Walker, Crosweller & Co. Ltd., Cheltenham.*)

Non-destructive measurements of the elastic properties in solid materials

A new aid to quality-determination in structural materials has recently been introduced by Aveley Electric Limited. The "E-G Meter" (Fig. 4) manufactured by Kretz, allows rapid and repeatable measurements of the dynamic modulus of elasticity (E), and the torsional modulus (G), of solids such as metal, concrete, rock, plastics, wood, coal, ceramics and other rigid materials. This wide range of applications by the E-G meter, is obtained by a simple and rapid operation, whilst the discrimination of the instrument gives repeatable measurements within 0.5 per cent. The dials are directly calibrated in both tons/sq. cm. and lb./sq. in. The provision for the use of five calibration units and push-button selection of ranges greatly speeds up the testing of a large number of samples. The 10 in. long slide-rule dial carries a calibrated scale for the common materials, and extra scales for special material. Accuracy of the instrument is claimed to be guaranteed by a built-in quartz-crystal controlled oscillator, providing check points on the dial. The equipment is also equipped with a pulse-transmitting test-probe and a mounted adjustable receiving probe, to ensure accurate application to the test sample. (*Aveley Electric Limited, Ayron Road, Aveley Industrial Estate, South Ockendon, Essex.*)

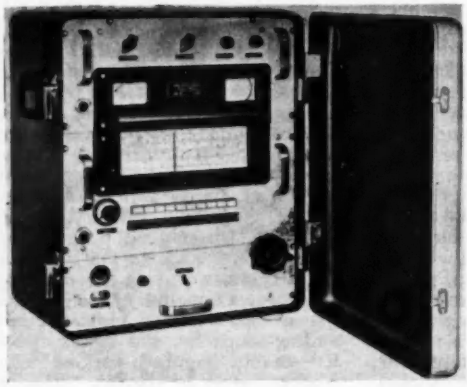


Fig. 4 (left). The "E-G Meter." (Aveley Electric Limited.)

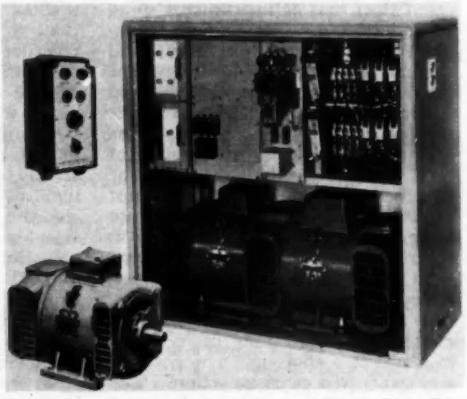


Fig. 5 (right). Packaged "Transidyne" drive. (Lancashire Dynamo Electronic Products Limited.)

Electro-mechanical valve

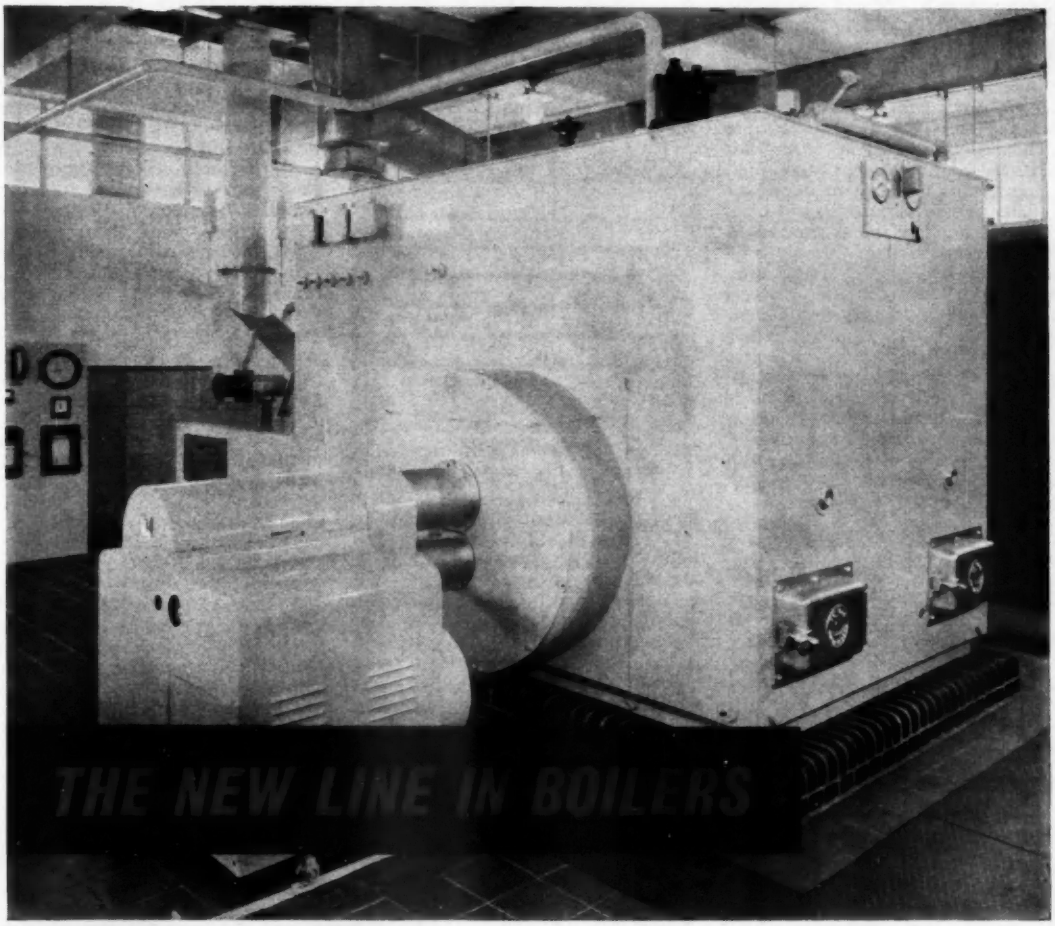
A motor-operated stop-valve which can also be used to regulate the flow of fluids, has been recently introduced by I.V. Pressure Controllers Limited. This valve, which varies in size from 3 in. to 10 in. dia., has a maximum working pressure of 550 lb./sq. in., and can also be manually operated by an over-ride mechanism. The motor is reversible, has a maximum torque of 170 lb. in., and requires a starting current of up to 4 amps. The electro-mechanical valve opens and closes according to the direction of rotation of a screwed spindle, which is operated by an actuator geared to a shaft running at a speed of 25 r.p.m. Motivated by this actuator, the spindle engages a split nut and opens and closes the valve as it moves upwards or downwards. Lowering of the spindle compresses, and thus loads, a spring; raising the spindle takes the load off the spring. In the event of an electrical failure, an isolating-switch automatically disengages the split nut from the screwed spindle. If the spindle is in the lowered position, the spring returns it to the raised position and the valve is opened or closed accordingly—depending on the type of valve seats fitted. On renewal of electrical supply, the weather and dust-proof actuator will function in the normal manner without adjustment. As a flow-regulating valve, a position indicator is employed to give electrical signals which can be translated into fluid flow. These signals are returned to the actuator and can open or close the valve from any intermediate position. (*I.V. Pressure Controllers Limited, Atlas House, 683, London Road, Isleworth, Middlesex.*)

Packaged "Transidyne" drive

Supplied in one package, complete with integrally-mounted motor-generator, the "Transidyne" drive (Fig. 5), manufactured by Lancashire Dynamo Electronic Products Limited, (a member of the Metal Industries Group) is now fully-rationalised in all ratings from 1-10 h.p. A wide variety of alternative control characteristics is also available, the desired features being assembled into the cubicle from a range of "off-the-shelf" sub-assemblies and plug-in control units. Using semi-conductor control techniques throughout, these drives are especially suited to applications involving overhauling loads, since regenerative braking is provided by the inherent characteristics of the motor-generator arrangement. The "Transidyne" drive is supplied complete with a remote-mounting control station which provides push-button starting, reversing and finger-tip speed-setting. (*Lancashire Dynamo Electronic Products Limited, Rugeley, Staffs.*)

Orders for air-blast switchgear

Orders worth about £700,000 have been received by The English Electric Co. Ltd. from the Central Electricity Generating Board for equipment for super-grid switching stations at Sundon, Bedfordshire and Feckenham, Worcestershire. The two 275-kV switching stations will be equipped with the latest design of air-blast circuit-breaker. The ten breakers, rated at 15,000-MVA, 2,000 A, will be made at the company's Stafford works. One of the new units is also being manufactured there for the Connah's Quay switching station, Flintshire. This station is at present equipped with breakers of the earlier 7,500-MVA design. The 275-kV, 15,000-MVA, 2,000-A air-blast circuit-breaker, designated "rT6C," is the first of a range of air-blast breakers being manufactured by the English Electric Co. Ltd., to cover voltages from 132-kV up to 550-kV or even higher. These breakers are fully - pressurised throughout in both the open and



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closed positions and do not incorporate a make switch, which is a feature of all current British air-blast breaker designs, including those manufactured to date by the English Electric Co. Ltd. This, coupled with the fact that the breakers are mechanically-operated up to the last stage, is said to ensure very high performance. The circuit-breaker is guaranteed re-strike free, and at all voltages has a total break time of 21 c/s maximum. The various voltage ranges are covered by using multiples of the same interrupter, which can be supplied for current ratings up to 4,000-A. The 275-kV, 15,000-MVA breaker incorporates six interrupters. The interrupters are shunted by linear switching-resistors and also by capacitors for ensuring voltage-division when the breaker is in the open position. (*The English Electric Co. Ltd., English Electric House, Strand, W.C.2.*)

Comprehensive range of calorifiers

Holden & Brooke Limited have recently introduced a complete range of non-storage calorifiers (Fig. 6) which, it is claimed, will adequately cover the requirements of heating engineers for this type of product. Available in two series, there are 19 sizes of the "Nordon" type and from these, capacities up to 8 million B.Th.U. can be obtained. The "Wython" calorifiers, which are built to B.S.S. 853, are manufactured in 16 sizes, the maximum capacity in this case being 6 million B.Th.U. Both types, for which the basic components are available from stock, can be assembled as horizontal or vertical units without affecting either price or delivery. The steam pressure limits on the primary side are 5 lb./sq. in. to 100 lb./sq. in. and the shell side maximum working pressure is 50 lb./sq. in. The construction is principally of welded mild-steel, with cast-iron steam boxes and solid-drawn copper "U"-tubes. (*Holden & Brooke Limited, Sirius Works, Manchester, 12.*)

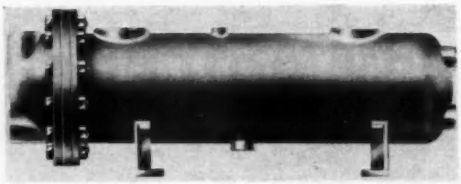

Fig. 6 (left). "Nordon" and "Wython" non-storage calorifiers. (Holden & Brooke Limited.)

New "Elfin" finned electric heater

A new and improved type of finned electric heating element (Fig. 7), which has just been introduced on the market by Eltron (London) Limited, should be of considerable assistance to heating and ventilating engineers. The conventional type of finned electric heater has the fins brazed or crimped on the tube wall. This improved type of heater, however, has the fins made from an "L" section. The fin section is tightly coiled around the electric heating tube giving, it is claimed, a very large area of contact, and a greatly increased transfer efficiency. Another advantage of fins of this type is that they are smooth and easily cleaned, as they do not have the pockets which tend to collect water and dirt, and which are generally found on the crimped fins. [*Eltron (London) Limited, Accrington Works, Strathmore Road, Croydon, Surrey.*]

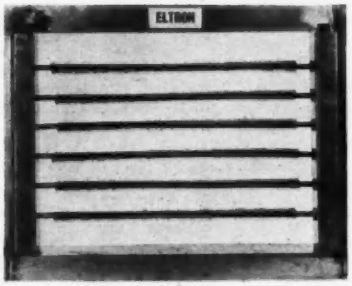

Fig. 7. "Elfin" finned electric heating element. [Eltron (London) Limited.]

Chemical pump in silicon-iron

The new 2 in./2½ in. "Hypersilid" chemical pump (Fig. 8), recently produced by Lee, Howl & Co. Ltd., is claimed to have an unusually wide range of applications—particularly in the chemical industry—but also in many other process industries, owing to its advanced design and corrosion-resistant properties. The pump is made from silicon-iron castings manufactured by Bradley & Foster Limited, and is suitable for the chemical and petro-chemical industries as well as for installation in trade-effluent treatment plants in industry generally. It is designed for the handling of such corrosive liquors as sulphuric-acid at any temperature or concentration, nitric, acetic, formic, phosphoric acids and many others. The outputs are: 153 ft. head—75 gal./min. maximum; 80 ft. head—187 gal./min. with maximum impeller diameter; 86 ft. head—65 gal./min. maximum; 51 ft. head—150 gal./min. with minimum impeller diameter. The speed is 2,900 r.p.m., and no wear rings are fitted, the impeller running-clearance being generous, thereby avoiding rapid loss in pumping efficiency from wear and corrosion. The various parts in contact with the acid are made of silicon-iron, while other parts are of best quality fine-grain grey-iron castings. The pump shaft is made of "Staybrite" steel, and is adequately protected against liquid drippings by a high-silicon iron wearing-sleeve extending through the whole depth of the stuffing box. The impeller and shaft assembly, it is claimed, can be quickly removed as a unit through the pump casing, without disturbing any of the bearings and other components. Two widely-spaced ball-and-roller bearings are fitted in the substantial cast-iron headstock. The casing is of the volute type, made from high-silicon iron, of ample wall-thickness to allow for design pressure under corrosive conditions, and is provided with a drain plug. The volute casing and suction cover are tested up to 100 lb./sq. in. The drive can be by motor on a common baseplate or by V-belt. (*Lee, Howl & Co. Ltd., Tipton, Staffs.*)

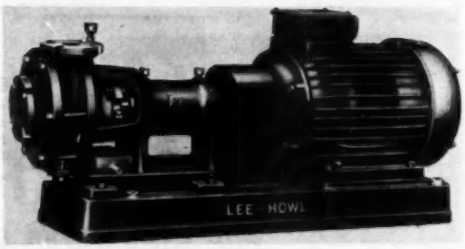

Fig. 8 (right). "Hypersilid" chemical pump in silicon-iron. (Lee, Howl & Co. Ltd.)

New hydraulic press

A new all-steel hydraulic press, of Italian design and manufacture, has recently become available in this country through the sole distributors, Rushworth & Co. (Sowerby Bridge) Ltd. This is the OMF-Ferralba "Delta" type open-gap press (Fig. 9) which has a capacity of 250 tons, a table surface of approximately 51 in. × 40 in.; and a stroke of 39⅜ in. Operating speed is 15 strokes/min. A 15 h.p. motor, direct-coupled to a multi-piston pump, operates the hydraulic system, which is provided

with an automatic valve for quick filling and discharging of the cylinder during idle strokes, and also with an adjustable slide stopping device. Control is either by push-buttons mounted on the side of the upright, which operate a servomotor, or by a manual control lever. The slide can also be controlled by means of push-buttons on a pendant in front of the machine. It is claimed that the

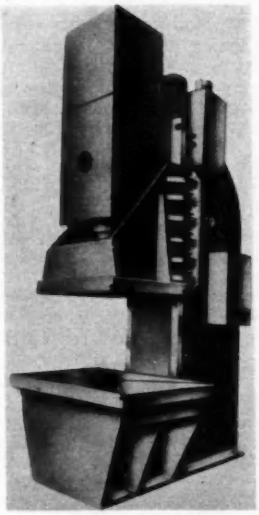

Fig. 9. OMF-Ferralba "Delta" type open-gap press. [Rushworth & Co. (Sowerby Bridge) Ltd.]

maximum tonnage is exerted throughout the entire stroke, the necessity of vertical die adjustment, therefore, being eliminated. A special feature of the design of the press is its "delta-shape" which is said to give exceptionally good accessibility to the table and to greatly facilitate the handling of bulky workpieces. High precision has been ensured by the provision of large surfaces for both piston and slides, which, by reducing friction, minimise wear on these working parts. The slides are protected by a steel guard. An interesting optional ancillary, available for operation with this machine, is an all-steel press-brake attachment which provides a maximum folding length of 9 ft. 10 in. Other optional extras are ejectors and a blank holder under the table. [*Rushworth & Co. (Sowerby Bridge) Ltd., Sowerby Bridge, Yorkshire.*]

G.E.C. annealing and decarburising furnaces

The General Electric Co. Ltd. has supplied to Richard Thomas & Baldwins Ltd. a number of electric furnaces for the processing of "Alphasil." This is a silicon steel of the grain-orientated type, used in the construction of cores for transformers and reactors. The furnaces are installed in the Cookley Works of the company at Brierley Hill, near Birmingham, and comprise a continuous-strip decarburising furnace, a continuous-strip inter-annealing furnace, and a number of bell-type furnaces for high-temperature annealing. Including the cooling chambers, the decarburising furnace is nearly 400 ft. long, and is believed to be the longest of its type in Europe. It is of the roller-hearth type, and receives steel-strip up to 32 in. wide. Having a maximum electrical rating of 1,700-kW, it operates with a controlled atmosphere. The inter-annealing furnace is of similar design to this furnace but its maximum electrical rating is 2,000-kW. (*The General Electric Co. Ltd., Erith, Kent.*)

"Rapide" steam trap, Series 2

The well-known "Syphonia-Rapide" steam trap has been completely redesigned and the new trap—the "Rapide" steam trap, Series 2—is now available from Royles Ltd. This new product (Fig. 10) is available in a range of sizes from 1 in. to 3 in. inlet and outlet, according to the particular discharge capacity required, and for pressure ranges up to 250 lb./sq. in. The "Rapide" operates on the open bucket float principle, and discharges the condensate, under pressure, with an intermittent action. The rectangular-shaped float, which is hinged on the valve itself near one end, gives a multiplying effect—enabling a larger bore of valve to be used—in consequence, a greater duty is obtained than would be the case if

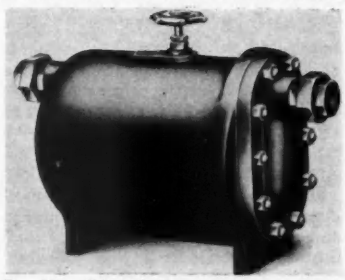

Fig. 10. "Rapide" steam trap, series 2. (Royles Limited.)

the valve were placed centrally. The gun metal valve is fitted with a renewable ball and seat of stainless-steel. It is placed low down, and is claimed therefore to be always water-sealed. The whole assembly of float valve and discharge pipe is carried on the cover at the outlet end, and may be withdrawn as a complete unit. Another feature is the provision of a thermostatic air-release to by-pass any accumulated air on starting up, or any that may accumulate during working. (*Royles Ltd., Irlam, Manchester.*)

Flame-controllers—Series 704

Ether Ltd. have developed a new range of flame-controllers for safely igniting and monitoring multi-burner installations in industrial concerns.

Fig. 11. Series 704 flame-controller. (Ether Ltd., Combustion Safeguard Division.)

They are said to be of the very latest design—fully transistorised, with plug-in circuitry and a.c. coupled amplifier—for use with gas-fired and oil-fired burners, or burners working on a combination of both fuels. Moreover, they are claimed to be able to discriminate between flame and flame-radiation, and are unaffected by the latter. "Series 704" flame-controllers (Fig. 11) can be supplied for controlling up to six flames at once, depending on specific requirements. Each flame is controlled by a "flame-eye," comprising a lead-sulphide cell, and a transistor amplifier which is sensitive to the modulated component in the flame-radiation. The presence of the flame is indicated by an output signal from the transistor-amplifier which, in turn, switches a silicon transistor. The circuitry of all "Series 704" flame-controllers is so arranged that the pilot-relay, which interlocks with the flame-relay and safe-start relay, cannot be energised until all the transistors are switched to "flame-on" positions. Absence of one or more flames will de-energise the pilot-relay and indicate an alarm condition. When switched on, the internal main connection is delayed for a pre-purge period that can be varied

between 30 and 120 sec. After the delay, an ignition-light switches on. A push-button is then pressed, which causes a solenoid valve in the pilot-burner line to open. Simultaneously, the ignition transformers produce sparks at the pilot-burner tips which ignite the pilot burners. The "flame-eyes" then monitor the flames and immediately register the "flame-on" position, whereupon the main solenoid valve is energised to open the main fuel supply. If flame-failure occurs, the pilot-valve and main-valve close, the control-valve closes to "low-fire" position, and the alarm signal is given. (*Ether Ltd., Combustion Safeguard Division, Caxton Way, Stevenage, Herts.*)

Sykes vertical self-priming pumps

New versions of the range of electrically-operated vertical-spindle self-priming pumps, now being produced by Henry Sykes Ltd. for sub-level operation, include improved impeller design, and an extensive use of spheroidal-graphite iron to eliminate electrolytic effects, arising from the use of dissimilar metals, for such parts as impellers and wearing plates. The range, which includes units of 2 in., 3 in. (Fig. 12), 4 in. and 6 in., suction and delivery, is said to meet a particular demand where it is necessary to keep a sub-level working floor as free as possible of equipment. Thus, by mounting the pump at some distance above the floor-level, ample head-room can be obtained whilst retaining the self-priming characteristic of a high-capacity, high-lift pump, leaving only a suction hose to the sump, which may be flexible and light, to manoeuvre to any required position. In these pumps, a totally-enclosed fan-cooled, weather-proof, high starting torque, low starting current induction motor, operating on 400/400 V, 3-ph, 50 c/s. supply is direct-coupled to the vertical spindle of a self-priming pump—the self-priming effect being achieved by the recirculation method. The unit is slung in a cradle formed by the twin delivery branches of the pump, which unite above the motor in a flanged Y-piece, to which may be fitted a gate-valve. The pump impeller is of the open type, allowing the passage of slurries of high solids content, and the volute is fitted with renewable wearing plates. The shaft is fitted with a renewable hardened sleeve, and is carried in large-diameter ball-races. The capacities of the range extend from that of the "VSP2"—a 2 in. unit which has an output of 6,000 gal./hr. against a total head from all causes of 90 ft., and 4,000 gal./hr. at 100 ft.—to that of the "VSP6"—a 6 in. pump which handles 50,000 gal./hr. at 70 ft. total head and 30,000 gal./hr. at a 90 ft. total head. The overall dimensions range from a length of 1 ft. 9 in., a width of 1 ft. 7 in. and a height of 4 ft. 9 in. for the "VSP2" pump to a length of 3 ft. 4 in., a width of 2 ft. 6 in. and a height of 8 ft. 8 in. for the "VSP6" pump. The weights for these two units of the range are 6½ cwt. and 27 cwt. respectively. (*Henry Sykes Ltd., Southwark Street, London, S.E.1.*)

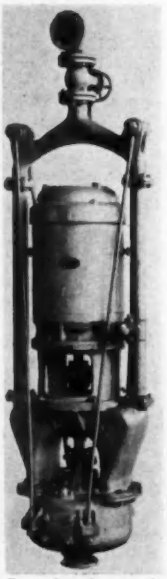

Fig. 12. Sykes vertical-spindle self-priming pumps. (Henry Sykes Ltd.)

Improved Diadem "Ruby" electrode

Elimination of objectionable welding fumes together with improved slag detachability are the main features claimed for the new Diadem "Ruby" range of electrodes, recently-introduced by Cooper & Turner Ltd. This mild-steel electrode is designed primarily for fast, high-quality welds in the downhand position, although it is also suitable for vertical and overhead work. The "Ruby" range has full M.O.T., Lloyd's and other official approvals. It complies with B.S. 639—1952, and B.S. 1856 regarding mild-steel welding requirements, and such other British Standards as B.S. 2642 covering the metal arc-welding of medium-tensile weldable structural-steel to B.S. 968. Due to careful matching of the core wire and covering, it is said to be particularly suited to the production of smooth dense welds of high strength, ductility and toughness, by welders of only limited experience. The "Ruby" range is designated E.217 on the B.S. 1719 coding, and E.6012 on the AWS—A.S.T.M. scale. The mechanical properties include a yield point of 24/28 tons/sq. in., an ultimate tensile strength of 29/34 tons/sq. in., and an Izod impact value of 50/70 ft. lb. The chemical analysis is carbon 0.08-0.10 per cent., silicon 0.11-0.14 per cent., manganese 0.55-0.65 per cent., sulphur 0.025-0.035 per cent., phosphorus 0.015-0.025 per cent. The electrodes are produced in a range of 10 sizes, from 16 gauge to ⅜ in., and are supplied in 14 lb. or 7 lb. standard packs, according to size. The deposition time per foot of electrode at maximum current is 55 sec. for an 8 gauge electrode and 68 sec. for a 4 gauge electrode. Current values are 170 A average and 190 A maximum at 8 gauge, and 290 A average and 315 A maximum at 4 gauge. (*Cooper & Turner Ltd., Vulcan Road, Sheffield, 9.*)

"Hydrocyclone" separator

In order to meet a demand in a variety of industries for a speedy and accurate method of separating or classifying solids suspended in a liquid, a new device known as the "Hydrocyclone" (Fig. 13) has recently been introduced. This is a wet centrifuge in the form of a cylindro-conical vessel into which the liquid to be processed is injected under pressure. The rapid rotary motion which is imparted to the liquid produces a very high centrifugal force, which forms two distinct vortices. The outer vortex carries the heavier solids to a nozzle in the apex of the instrument from which they are discharged, together with some liquid. The lighter solids are entrained in the inner vortex to an axial overflow at the opposite end. Owing to the very strong shearing forces also produced, the "Hydrocyclone" is claimed to be effective even with pulps of high solid-granular particles, and those which settle by means of flocculation or other forms of aggregation are said to make it particularly useful for cleaning such difficult materials as fibrous pulps. The "Hydrocyclone" is of simple construction and consists of a body, normally of cast-aluminium or fabricated mild-steel, with a lining of special abrasion-resistant rubber. The upper part contains the vortex finder and overflow, and an easily removable nozzle of solid rubber is fitted to the apex. To provide maximum protection against abrasion, which intensifies as the diameter lessens, the walls of the nozzle increase in thickness towards the orifice. In the smaller sized units

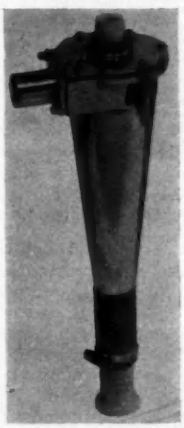

Fig. 13. "Hydrocyclone" separator. (Liquid - Solid Separations Limited.)

the rubber body lining is replaceable. The "Hydrocyclone" is produced in models with capacities ranging from 4 to 1,200 gal./min. For fine separations at higher capacities, batteries of "Hydrocyclone" of 15 or 30 mm. (0.59 in. or 1.18 in.) diam. can be installed. In suitable cases, separations down to 5 microns are possible. This unit is being used extensively in laboratory research, and among its many potential applications in various industries the following can be mentioned:—degritting of cutting, grinding and honing fluids and of rolling-mill cooling-water, dewatering of slurry, desliming of sand as well as degassing, deflocculation and general classification and washing operations. (*Liquid-Solid Separations Ltd., 2, Anderson St., London, S.W.3.*)

Davidson & Co. Ltd., Belfast, the well-known manufacturers of fans and dust-collectors, have completed an agreement with the German firm, **Apparatebau Rothemühle,** for the manufacture under licence, of that company's regenerative air-preheater. The licence extends to the manufacture and sale of this equipment in the United Kingdom and various overseas territories. This new "Sirocco" product will be marketed under the name of the Davidson Air-Preheater (manufactured under licence of Rothemühle patents). A considerable number of enquiries for the Davidson air preheater have already been received, and arrangements for its production are now well advanced.

* * *

Associated Electrical Industries Ltd. is to receive an order from the West Midlands Gas Board for an unusual back-pressure turbine-generator to be installed in the board's Coleshill Gas Works near Birmingham. The unit will supply electrical power and process steam for the new Lurgi gasification plant at Coleshill. Rated at 4,725-kW, the turbine will be designed for the very advanced steam conditions of an initial pressure and temperature of 2,500 lb./sq. in., and 940 deg. F., and it will exhaust at 450 lb./sq. in. The turbine will run at 8,000 r.p.m., and will drive the generator running at 1,500 r.p.m. through single-reduction, single-helical hardened and ground gearing. A gear-box of this type offers the advantages of small size and long life. It has been developed as a result of A.E.I. experience in the design and use of hardened and ground gears for marine gas- and steam-turbine applications. The generators will be a salient-pole machine supplying 3-phase, 50 c/s current at 6,600 V.

* * *

Amongst epicyclic gear contracts received recently by **W. H. Allen Sons & Co. Ltd.** are two important export orders for gear units for boiler feed and circulating-water pump drives. For installation in the Vales Point Power Station of the Electricity Commission of New South Wales, Australia, nine Allen-Stoeckicht gear units for booster and boiler feed-pump drive have been ordered by Mather and Platt Ltd., Manchester—each designed to transmit 3,450 h.p. continuously, and to increase the motor speed of 1,470 r.p.m. to the pump speed of 5,000 r.p.m. Two Allen-Stoeckicht epicyclic reduction gear units for circulating-water pump drive, for installation in the Komati Power Station, of K.S.B. Pumps, have been ordered by Dowson & Dobson Limited, South Africa, each gear being designed to transmit 2,140 h.p. continuously and decrease the motor speed of 1,485 r.p.m. to the pump speed of 365 r.p.m. All the above gears will be built at the company's Atlas Works, Pershore.

The Electrical Research Association recently announced the composition of Divisional Committee No. 2—Power Plant, which held its first meeting on May 4th, 1961:—viz. Mr. E. S. Booth, chairman, (Central Electricity Generating Board); Dr. A. T. Bowden (C. A. Parsons & Co. Ltd.); Mr. J. Caldwell (The English Electric Co. Ltd.); Mr. W. W. Campbell (Merz & McLellan); Dr. W. H. Darlington (Associated Electrical Industries Ltd.); Mr. F. Dransfield (Central Electricity Generating Board); Mr. M. G. Gemmill (Central Electricity Generating Board); Mr. J. B. Jackson (Central Electricity Generating Board); Mr. E. Hywel Jones (South of Scotland Electricity Board); Mr. K. J. McKillop (Water-Tube Boilermakers' Association); Mr. J. Mayer (International Combustion Ltd.); Mr. J. M. Mitchell (The General Electric Co. Ltd.); Mr. C. W. Priest (Central Electricity Generating Board); Mr. W. F. C. Schaap (Babcock & Wilcox Ltd.). Dr. H. G. Taylor, director of the Electrical Research Association, is an *ex officio* member of the committee, and the secretary is Mr. G. A. W. Taylor of the Electrical Research Association.

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P.T.F.E. (polytetrafluoroethylene) is a thermoplastic used in a wide range of industries. Until recently the smallest diameter rod of P.T.F.E. generally available measured about 0.050 in. but now **Richard Klinger Limited** have developed a very fine mono-filament of only 0.007 in. dia. which can be woven or knitted into a mesh. This new development in plastics means, generally speaking, that quite a number of filters, demister, separators and similar items of equipment, at present manufactured in metal, will be replaced by P.T.F.E. Properties of P.T.F.E. include: complete resistance to almost all chemicals, working temperature range from absolute zero to 300 deg. C. (572 deg. F.), excellent, non-conductive properties and, therefore, suitable for electrical insulation, completely unaffected by varying weather conditions, very low coefficient of friction roughly equal to wet ice against wet ice. Several firms likely to be interested in P.T.F.E. filament have been asked for their opinions on the new filament and as a result there is already a heavy demand for it although Richard Klinger Ltd. have not as yet commenced full production.

* * *

Mr. E. Heys, A.M.I.E.E., has been appointed manager, Electronic Sales Department (Manchester) of the AEI Electronic Apparatus Division. When the Electronic Apparatus Division was formed in 1959, Mr. Heys became assistant manager, Computer Sales Department, and acting assistant manager, Servo Sales Department, positions he held until his present appointment.

Mr. W. B. Shannon, M.Inst.C.E., M.I.Mech.E., M.I.E.E., has retired from his position as assistant chief project engineer of the Central Electricity Generating Board's Southern Project Group. In 1926, Mr. Shannon joined the London Electric Supply Corporation and London Power Co. Ltd. He was appointed assistant progress and inspection engineer in 1929, and became chief assistant constructional engineer in 1934. In 1948, he joined the South Eastern Division as chief generation engineer (construction) retaining the position until September 1954, when he was appointed chief generation engineer (construction) in the London Division. In 1958, he was appointed assistant chief project engineer in the Southern Project Group, the post he has now vacated.

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Mr. R. G. Huxtable, M.B.E., is to be the new secretary of The Gas Council. On August 1st, he succeeds **Mr. Wilfrid Bailey,** who becomes deputy chairman of the Southern Gas Board. Mr. Huxtable has been secretary of the South Eastern Gas Board since 1956, and was previously the Board's solicitor.

* * *

A new booklet, entitled "Talking About Wards," has been published by **Thos. W. Ward Ltd.,** Albion Works, Sheffield, which aims to present in the shortest possible manner an outline of the activities of the Ward Group of Companies. Copies are now being made available to all past customers and to prospective ones. The booklet obviously cannot cover every aspect of this complex organisation, but it does attempt to give an answer to the many questions likely to be asked concerning the organisation.

* * *

Pressure-gauges, thermometers and special control instruments manufactured in Holland are now being marketed in the United Kingdom. **Cockburns Ltd.,** Cardonald, Glasgow, are to act as British selling agents for the **E.N.F.M. Company** of Schiedam, Holland. E.N.F.M. instruments have been developed largely in conjunction with leading oil engineers, and the company were one of the originators of metering instruments for the oil industry. E.N.F.M. pressure gauges, vacuum meters and hydrometers are of the compound type, with zero adjustment, and therefore are capable of "in situ" calibration. Dial thermometers manufactured are of the mercury-in-steel type, for vertical or angled mounting. Special E.N.F.M. instruments to be marketed by Cockburns are, automatic sampling units, and a temperature-indicating controller for oil tankage. The sampling units can be adjusted for size and frequency of sample, and can be fitted with special intervals for operation with corrosive fluids.

OVERSEAS Steam Engineering Practice

Abridgments of recent articles in the colonial and foreign technical press, concerning design and progress in the technique of steam generation and power plant equipment

Pneumatic material-handling system

Installation of a pneumatic material-handling system has improved the method of fly-ash disposal at the Atomic Energy Commission, 300 Area, steam generation plant, located near Richland, Washington, U.S.A. The steam generation plant is part of Hanford Atomic Products Operation which is being operated for the government by the General Electric Company. Process and heating steam for the 300 area is produced by six coal-fired boilers equipped with spreader stokers. All the boiler flue-gas is passed through one of the three mechanical fly-ash separators before being discharged to atmosphere. Before the new system was installed, fly-ash from five existing boilers was collected by two separators. One separator discharged fly-ash by gravity into the base of a 150 ft. high brick chimney. The other separator also discharged fly-ash into the chimney by means of a reinjection nozzle and blower combination, which transferred the fly-ash 85 ft. through a 4 in. pipe to the chimney. Periodically, fly-ash was removed from the chimney base by a sluicing operation that washed the fly-ash down a trench to an ash-pump pit. From here the fly-ash and water mixture was pumped 900 ft. to a disposal pond outside the area. This system was unsatisfactory because sufficient force was not available for removing fly-ash from the separator hoppers. As a result, the hopper discharge-openings were frequently blocked, fly-ash filled the hoppers, and the separators were put out of service. Furthermore, when the chimney base was sluiced, the ash pump had to be operated, requiring the services of two men and 1,800 gal./min. of water. The basic pneumatic handling system was installed with a new fly-ash separator some 18 months ago, when the sixth boiler was added to the plant. Since that time, the system has been modified and extended so that it is now used for removing fly-ash from all separators. Each separator hopper discharge-opening is equipped with a remote-manual material-handling valve. There are two branch lines in the system, each being equipped with a remote-manual segregation-valve which reduces system leakage when a particular branch line is not in service. A water jet exhauster is used to create the necessary vacuum for producing air-flow to convey fly-ash through the transport piping. The fly-ash and water mixture discharged from the hydrovactor passes through an air separator tank and then flows to the disposal pond, and one man operates the entire system from a centrally-located control panel. With the air-valve in the open position, 100 lb./sq. in. compressed air is admitted to the material-handling valve or segregation-valve actuating air cylinder. One separator hopper is emptied at a time. The water-jet exhauster uses about 700 gal./min. of water and the system transports fly ash at the rate of 10 tons/hr. This pneumatic-handling system has reduced water consumption and saved manpower. In addition, it has contributed to the reduction of the quantity of residual fly-ash that is emitted from the steam generation plant because of the more efficient removal of fly-ash from separator hoppers. (*Combustion*, Vol. 32, No. 10, April, 1961, p. 51.)

Second part of Snowy River scheme

Work will begin shortly on the second stage of the Snowy Mountains hydro-electric undertaking. The first stage diverted the Eucumbene, Upper Murrumbidgee and Tooma rivers into the Tumut. The second will divert water from the Snowy River, through a series of tunnels, reservoirs and power stations, into the Murray Valley. There will be three tunnels, having a total length of 31 miles, three dams and the 760-MW Murray power station, the largest in the scheme. Its first units are scheduled to begin operating in 1966 to relieve peak winter loads in New South Wales and Victoria. The first of the approved works in the second stage is the 15-mile Eucumbene-Snowy tunnel, which will permit flow in either direction and will be used at first to divert water from the Snowy, from Island Bend to Lake Eucumbene, for storage. Other approved works, including a nine-mile trans-mountain Snowy-Geehi tunnel and the Murray power station and pressure tunnel, will allow water to be returned to Island Bend and diverted westward to the Murray River.

Higher temperature for thermo-electricity

A new group of ceramic-type thermoelectric materials, which permit the direct conversion of heat into electricity at temperatures considerably above the melting point of copper, has been developed by the Westinghouse Electric Corporation, New York, U.S.A. The new materials are compounds of samarium and cerium—two metals belonging to a family of "rare earths." In the new materials, the metals are chemically combined with sulphur to form differing varieties of two compounds—samarium sulphide and cerium sulphide. In particular, these new materials show advantages due to their excellent high-temperature stability, and their thermoelectric efficiencies at temperatures as high as 2,000 deg. F. Work on these materials commenced when studies, being carried out at Westinghouse, indicated that certain of the "rare earth" materials might have desirable thermoelectric properties. Until this time, research on rare earths had included little work on the preparation and properties of their sulphides. Two families of "rare earth" sulphides can be prepared in a similar manner—by directly combining the pure metal with sulphur. In the case of samarium sulphide, the samarium and sulphur are heated to high temperatures in a protective atmosphere. The rate of temperature rise, final temperature attained, and length of reaction time must be very carefully controlled. Following the chemical reaction between the samarium and the sulphur, the resulting sulphide is then crushed, compacted into small pellets, and sintered in a vacuum induction furnace. The composition of the various sulphides which result from the metal-sulphur reaction is

determined by X-ray diffraction analysis. Physical, electrical and chemical tests are then made on the completed thermoelectric pellets. There are many types of thermoelectric material now available, each having its own optimum temperature. Normal practice when constructing a thermoelectric machine, therefore, is to use several thermoelectric junctions, each working at its favoured temperature and passing its waste heat to the next one. In this way it is possible to construct a fairly efficient machine up to moderately high temperatures. The advantage with these materials, therefore, is that the upper temperature can now be raised. This not only increases the range of heat sources that can be used to obtain electricity directly from heat, but it also provides an overall increase in thermal efficiency, particularly in view of the well-known fact that heat engines always operate in a more efficient manner when working at higher temperatures.

Following on the recent order for four complete sets of condensing and feed-heating plant of entirely new design for Tilbury "B" Power Station, the **Richardsons Westgarth Group** have received a further order from the Central Electricity Generating Board for the condensing plant for a 300-MW turbo-generator set at West Thurrock Power Station. The value of this order is approximately £300,000.

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W. H. Allen Sons & Co. Ltd. have received orders for twelve epicyclic gears for boiler feed-pump drives in the Drakelow "C" (supercritical), West Burton, and Richborough power stations of the Central Electricity Generating Board. For the Drakelow "C" (supercritical) power station, two gear units, ordered by Sulzer Bros. (London) Ltd., are designed to increase normal motor speeds to the high rotational speeds required for modern boiler feed-pumps, and each is capable of transmitting approximately 10,000 h.p. continuously. For the West Burton power station, eight gear units, ordered by Mather & Platt Limited, are to be supplied, and are designed to transmit 9,100 h.p. continuously each, and increase the motor speed of 1,470 r.p.m. to the pump speed of 4,800 r.p.m. For the Richborough power station two gear units, ordered by the Harland Engineering Co. Ltd., Alloa, are designed to transmit 2,600 h.p. continuously each and increase the motor speed of 1,490 r.p.m. to the pump speed of 5,500 r.p.m. All the above gears will be built at the company's Atlas Works, Pershore, Worcestershire.

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Ardleigh Engineering Limited, Colchester, announce the signing of agreements with Curtiss-Wright Corporation of Wood-Ridge, New Jersey, U.S.A., which give Ardleigh the right to manufacture under licence, the model EHP hydraulic speed governor being produced by Curtiss-Wright Europa N.V. at Leiden, Holland. Under the agreements, the Leiden factory will operate under the name of Regulateurs Europa N.V. as Ardleigh's subsidiary company, and will continue to make and sell the EHP governor as before. The new company will assume responsibilty for the service of governors already delivered. In addition, the two parent companies, **Ardleigh Engineering** and **Curtiss-Wright Corporation,** have entered into a technical evaluation agreement which gives each the right to manufacture or distribute each other's complete governor product lines in specified territories. The governor product lines of each company are complementary, and this agreement has been adopted in order to give each company a broader product line to manufacture and sell.

Whitfield Industrial Developments Ltd., Woolston, Southampton, announce that the **Diamond Power Specialty Corporation** of Lancaster, Ohio, U.S.A., have acquired their three subsidiary companies, the Diamond Blower Co. Ltd., Ferry-Diamond Engineering Co. Ltd. and Fyrex Limited. These three companies are all engaged in the engineering field, and manufacture boiler-cleaning plant, pumps, filtration plant and fire-fighting equipment. The Diamond Power Specialty Corporation is a subsidiary of the Babcock & Wilcox Company (U.S.A.), and is the major producer of boiler-cleaning equipment, water-level gauges, closed-circuit television systems for industry and nuclear engineering products. Commenting on the purchase, Mr. W. J. Fitzburgh, president of the Diamond Power Specialty Corporation, stated: "We have been impressed by the activities of these companies in Southampton, and look forward with pleasure to having them associated with us. These enterprises will have the full benefit of Diamond Power's products and research development programmes, which, we are confident, will enable them to extend their existing markets throughout the world." The three companies will be combined under the control of the Diamond Blower Co. Ltd., and **Mr. Harold V. Gort,** formerly the controlling shareholder of all the companies, will continue to serve as managing director.

* * *

To meet increasing sales activity in the London and Home Counties area, **Holden & Brooke Limited,** manufacturers of a wide range of centrifugal pumps, reciprocating pumps and heat-exchange plant, have moved their London office from Victoria Street, S.W.1, to larger premises at Elystan Mansions, 105/109, Fulham Road, London, S.W.3. Telephone Knightsbridge 6766/9. In addition to accommodating an expanding sales force, the new offices will eventually house a permanent display of Holden & Brooke products. **Mr. H. J. Moore,** sales director, will continue in charge. The firm's head office address is Sirius Works, Manchester 12. Telephone Ardwick 3883.

* * *

Sir Harold Hartley, G.C.V.O., C.B.E., M.C., F.R.S., has been made an honorary member of the **Institute of Fuel.** For more than 40 years Sir Harold has been prominent in concern with fuel matters. He was chairman of the Fuel Research Board of the D.S.I.R. from 1932 to 1947; chairman of the British National Committee and of the International Executive Council of the World Power Conference from 1935 to 1950; and president of the Conference from 1950 to 1956.

A new 14 in. merchant bar and section mill is to be installed at the Wolverhampton works of the **Wolverhampton & Birchley Rolling Mills Limited,** a member of the **Thos. W. Ward Group of Companies.** Work on the new project will commence in the near future, the total cost being more than £500,000. Orders for the new plant have been placed with **The Brightside Foundry & Engineering Co. Ltd.,** Sheffield, the rolling mill and its equipment costing more than £300,000. The Structural Steelwork Department of the parent company—Thos. W. Ward Limited—will erect the buildings to accommodate the new mill, and five new overhead electric cranes will be supplied and installed by **John Smith (Keighley) Limited,** another member of the Ward Group. The scheme will take about 2/2½ years to complete, and will increase the productive capacity of the company to approximately 150,000-tons of steel bars and sections per annum.

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Bastian & Allen Limited, a division of the **Parkinson Cowan** group, have received an order for what is believed to be the largest electrode hot-water boiler ever manufactured. The boiler will be rated at 18,000 kW, operating at 13.2 kV, with an output of 60,000,000 B.Th.U. under a working pressure of 350 lb./sq. in. and delivering water at 380 deg. F. This boiler has been ordered through the company's agents in Montreal, Modenco of Canada Limited, and is for the Iron Ore Company of Canada at their Carol Lake project in Newfoundland. It will be used for a high-pressure hot-water heating scheme for the many buildings at this mine. Current will be supplied by Hydro-Quebec Power and will save the transportation of oil to the mine.

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A £40,000 contract for the supply of materials for, and erection of, a 132-kV grid link in Lincolnshire has been awarded to **Associated Electrical Industries Ltd.** The work will be carried out for the Central Electricity Generating Board (North Eastern Region), by A.E.I. Construction (Cables and Lines) Division. A 6¼-mile steel tower line will connect a new 132/33-kV sub-station to be built at Blyton, 10 miles south of Scunthorpe, and the existing Keadby-Wold Newton 132-kV line at a point near Messingham. Initially, only one circuit is to be erected on the new line, which is scheduled for completion during the summer of 1962.

* * *

The London office of **Crofts (Engineers) Limited** has moved from 34, Norfolk Street, Strand, London, W.C.2, to new premises at 36/42, Tanner Street, Bermondsey, London, S.E.1. Telephone HOP 7751/4.

Latest Power Plant Patents

These extracts from British Patent Specifications are reproduced by permission of The Controller of H.M. Stationery Office. (Complete British Specifications can be obtained from the Patent Office, 26, Southampton Buildings, London, W.C.2. Price 3s. 6d. each, both inland and abroad.)

System for indicating combustion conditions

This invention relates to a method and system for sensing and indicating combustion conditions in a combustion chamber, and is more particularly concerned with sensing differences in combustion rate, such as detecting the absence or presence of combustion or flame in the chamber, and transmitting this information to a signal or other indicating device located at a control point remote from the combustion chamber. In connection with some types of burners, and in furnaces where a number of these burners are employed, it has hitherto been necessary, because of the type and nature of sensing devices used, to place a sensing device adjacent to each burner. In case of loss of fire on one burner, the fuel and air mixture flowing to this burner is shut off. This detrimentally affects the air-fuel ratio of the mixture being delivered to the remaining burners, thereby greatly increasing the possibility of the entire furnace losing ignition and causing a complete shut-down of the steam generator. Such interruptions of service are undesirable because they increase maintenance cost and decrease stability of operation and availability of the unit. This invention overcomes, or greatly diminishes, these difficulties through the use of a superior indicating system. The functioning of the new system is based on reliable pressure differences received by a pressure-differential switch from the combustion chamber in question, such as a pilot torch nozzle, or an entire furnace, for indicating the presence of combustion or flame within the combustion chamber. This is accomplished by positive and dependable means and with practically no delay in action. Referring to Fig. 1, an elongated combustion chamber (10) is bounded by walls (12). Fuel in a gaseous, liquid or pulverised form enters the chamber (10) by way of a nozzle (14) and, after mixing with air entering by way of a slot (16), is ignited by a device (17) and burns at least partially within the combustion chamber (10). The generated combustion gases leave the chamber (10) via the outlet (18). A pressure differential responsive device (20) is operatively connected to two openings (22 and 24) provided in the wall (12) of the chamber (10), such connection being effected by conduits (26 and 28 respectively). The device (20) accordingly maintains static pressure communication with the interior of the chamber (10). The opening (22) is located adjacent to the fuel and air inlet-end and the opening (24) adjacent to the combustion-gas outlet-end of the chamber (10). If combustion is absent in the chamber (10) and the effect of air flow is neglected, the static pressure (P), measured at the opening (22), is found to be the same as the static pressure (Q) measured at the outlet (24). The pressure-differential responsive device (20) accordingly records a differential pressure of zero. However, as soon as the fuel and air mixture is ignited and combustion is taking place within the chamber (10), the static pressure (P) observed at the fuel inlet-end rises and the static pressure (Q) observed at the gas outlet-end drops, so that a positive pressure-differential (P-Q) is almost instantly indicated by the instrument (20). It is this phenomenon of change in pressure-differential, between a state of combustion and a state of non-combustion, which is being made use of in this system. *British Patent No.* 866,135 *issued to Combustion Engineering Inc. Complete specification published April 26th,* 1961.

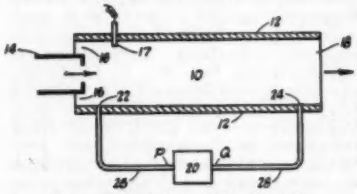

Fig. 1. British Patent No. 866,135.

Superheater

This invention relates to steam superheaters, and generators including superheaters. For the purpose of keeping constant the temperature at which steam emerges from a superheater, arrangements are known which regulate the temperature of the steam by the injection of water or steam into the superheated steam, and it is also known to cool the outer surfaces of the superheater tubes by means of a liquid or gaseous cooling medium. In the latter arrangements, the surface heat-exchangers are situated outside the boiler walls and are connected to a part of the superheater tubes disposed in the flow of the flue gases. These arrangements, however, have the disadvantage that they are disposed between two superheater stages or otherwise have superheater heating surfaces following them, with the result that, after leaving the regulating device, the steam is subjected to influences which are no longer controllable. The consequence of this is that it introduces delays in the regulating process. In the arrangement shown in Figs. 2-5, the superheater comprises tubes (1) which extend from the interior of the combustion-gas flue (2), where they form heating surfaces (H), through the boiler brickwork (3), to the outside of the combustion-gas flue where they form cooling surfaces (K). The cooling surfaces (K) are situated in a heat exchanger (4), which has a regulating-valve (5) and is divided into several chambers (4a) connected in parallel in respect of the flow of cooling medium Each of the cooling chambers (4a) is equipped with an adjustable sliding plate or damper (6). The steam flows in series through the superheater tubes in the direction of the arrow " a " (Fig. 2), while the cooling medium flows through the heat-exchanger (4) in countercurrent to the steam. In the embodiment described, a gaseous cooling medium is provided, for example air, which, after leaving the heat exchanger (4), may be used as preheated air for combustion in the steam-generator furnace. In the same way it is, of course, possible to construct the heat-exchanger and the regulating means in such a manner that a liquid cooling medium can be used, in which case boiler feedwater to be pre-heated could serve as cooling medium. As will be apparent from the circuit diagram in Fig. 5, the steam outlet temperature may be kept constant with the aid of a temperature regulator (7) with error control, the regulator being connected by leads (8) to a pair of thermo-couples (9 and 9a) in the steam pipe (D). One of the thermo-couples (9) is situated up-

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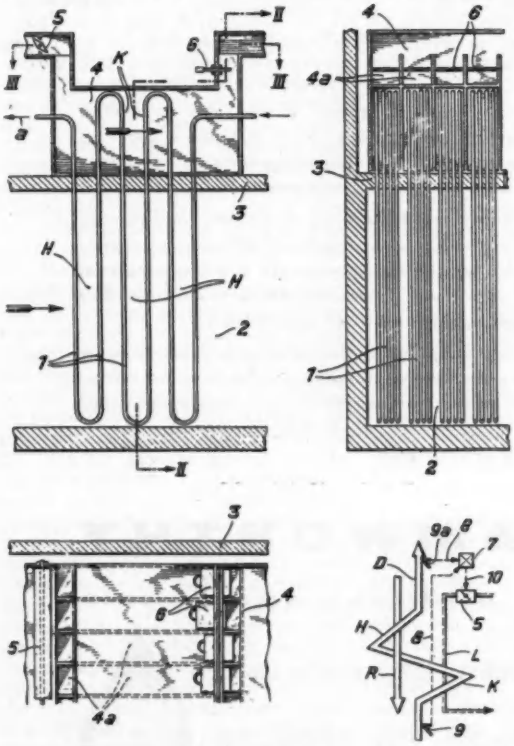
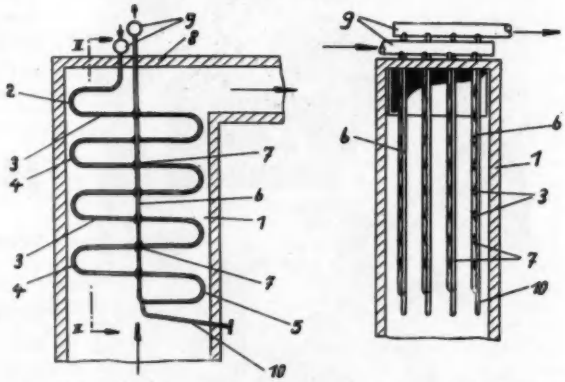
stream of the heating surfaces (H) and cooling surfaces (K) of the superheater, while the other thermocouple (9a) is disposed downstream of the surfaces. The heating surfaces (H) lie in the current of flue-gas (R), and the cooling surfaces (K) are exposed in the heat-exchanger (4) to the current of cooling medium (L). The flow of cooling medium is regulated by means of the regulating-valve (5) which in turn is controlled by the temperature regulator (7), to which it is connected by a lead (10). An additional adjustment (normally having to be carried out once only) of the admission of cooling medium to the cooling chambers (4a) can be carried out by appropriate operation of the dampers (6), and is used primarily to compensate for possible uneven temperature gradients in the superheater. In the case of steam generators having more than one superheater, one or more of the superheaters may be constructed according to the invention, and where more than one superheater is so constructed, the temperature regulators of the superheaters can be coupled together, and adjusted to give the desired final steam temperature. *British Patent No.* 866,275 *issued to Sulzer Frères S.A. Complete specification published April 26th,* 1961.



Figs. 2 and 3 (left), and 4 and 5 (below left). British Patent No. 866,275.

Fig. 6 (below and below right). British Patent No. 866,875.



Superheater coil

This invention relates to pipe structures in which a pipe is bent to serpentine form, with a number of horizontal limbs united by return bends lying in a common plane. It is known to secure the horizontal limbs of superheater-pipe structures of this kind, to separate vertical supporting pipes lying in the same plane, and through which a cooling medium flows. In one constructional form the return bends of two adjacent horizontal limbs, lying in a common plane, are connected by interwelding short strips of flat iron to a supporting chain, lying in the prolongation of the supporting pipe. In another known constructional form, in the plane of the serpentine structure a separate supporting pipe is passed alongside at the return bends, and each return bend is welded to a supporting pipe through a short strip. In contradistinction to these known constructions the invention consists of a pipe structure wherein the lowermost horizontal limb is bent upwards to form an upwardly extending supporting member to which the remaining horizontal limbs, which are crossed at right angles, are connected by welding or screwing. In this way, pipe structures for superheaters, preheaters, and the like may be formed, for the suspension of which separate supporting pipes through which a coolant flows are not required. Referring to Fig. 6, heat-exchange surfaces, which are formed of pipe coil units (2), are arranged in a smoke gas conduit (1), being suspended side by side and parallel to one another in it. Each coil is so constructed that the pipe limbs (3) lying horizontally in a common plane, and connected to one another by means of return bends (4), are in serpentine form, the lowermost return bend (5) of which extends to the middle of the adjacent pipe limb (3) and is there bent vertically to extend across the pipe limbs (3) in such a manner that the upwardly extending pipe portion (6) forms with the horizontal pipe limbs (3) substantially right-angled intersection points (7). At these intersection points (7), the pipe limbs (3) are connected to the upwardly extending pipe portion (6) by welding or screwing, i.e. by means of suitable clips, so that a pipe unit is formed. The extreme ends of the pipe coils forming each unit are connected to a header (9) arranged above the cover (8) of the smoke gas conduit. At the lowermost end of each unit a draining pipe (10) is provided which extends to the outside of the smoke gas conduit (1). Upon such draining pipes, known means may be arranged to act, e.g. striking devices or the like in order to set the pipe coils in vibration for the purpose of cleaning them from soot and ash deposits. *British Patent No.* 866,875 *issued to Schmidt'sche Heissdampf-Gesellschaft m.b.H. Complete specification published May 3rd,* 1961.

Steam-turbine power plant

This invention relates to steam power plants arranged to receive steam from steam-generating and superheating units. According to the invention, in steam-turbine power

plant including a steam-turbine and means for heating feedwater by means of steam bled from the turbine, provision for heating combustion air includes first combustion-air heating means adapted to effect heat-exchange between combustion air, already partially heated, and bled-steam in superheated state. The feedwater heating means are arranged to receive the bled-steam after it has been at least largely desuperheated. Referring to Fig. 7, the chain dotted line *A-A* separates heat exchangers, associated with the flow of hot gases through the steam generating and superheating unit, from the steam-turbine and equipment associated more directly with that turbine. The dotted line *B-B* indicates the flow of hot furnace gases through that unit, and the arrowhead on that line indicates the direction of gas flow. Disposed in that gas flow are a steam superheater (1), a steam reheater (2), an economiser (3) and an air-heater (4), suitably of the rotary regenerative type. The steam-turbine includes a high-pressure stage (5), arranged to receive steam flowing from the superheater (1), and to discharge partly expanded steam to the reheater (2) and a low-pressure turbine stage (6) arranged to receive steam from the reheater (2), and to discharge steam to a condenser (7). An extraction pump (8) is arranged to extract condensate from the condenser (7) and to force it through series-connected feedwater heaters (11, 12 and 13) of the closed type to the inlet to the economiser (3). A forced-draught fan (20) is arranged to supply air to a distributor (21), from which part of the air flows through a conduit (22) to the air-heater (4), and thence through another conduit (30) to the combustion apparatus of the furnace associated with the steam generating unit, and from which the remainder of the air flows through a conduit (31) to a steam-heated air-heater (32). The outlet of the air-heater (32) is connected through a distributor (33) to a second steam-heated air-heater (34), the outlet of which is connected through a distributor (33) to a second steam-heated air-heater (34), the outlet of which is connected through a distributor (35) to a third steam-heated air-heater (36), the outlet of which is connected through a distributor (37) to a conduit (38) connected to the combustion apparatus mentioned above. The turbine low-pressure stage (6) is provided with three steam bleeds (60, 61 and 62) from different pressure points in the stage, one bleed point (60) being at the lowest bleed-pressure and another bleed (62) being at the highest bleed-pressure. The first bleed (60) heats

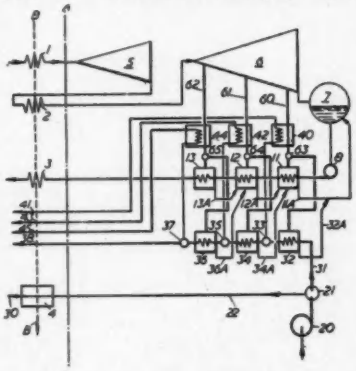


Fig. 7. British Patent No. 866,342

the steam-heated air-heater (40), divided in a distributor (63) into two streams of desuperheated or substantially desuperheated steam, one of which heats the feedwater heater (11) and the other of which heats the steam-heated air-heater (32). Condensate from the heaters (11 and 32) is extracted by drains (11*A* and 32*A* respectively) and fed to the condenser (7). The second bleed (61) heats the steam-heated air-heater (42), divides in a distributor (64) into two streams of desuperheated steam, one of which heats the feedwater heater (12) and the other of which heats the steam-heated air-heater (34). Condensate from the heaters (12 and 34) is extracted by drains (12*A* and 34*A* respectively) and fed to the heating steam/water space of the feedwater heater (11). The third bleed (62) heats the steam-heated air-heater (44), divides in a distributor (65) into two streams, one of which heats the feedwater heater (13) and the other of which heats the steam-heated air-heater (36). Condensate from the heaters (13 and 36) is extracted by drains (13*A* and 36*A* respectively) and fed to the heating steam/water space of the feedwater heater (12). During operation of the steam-turbine plant and steam generating unit, hot gases produced in the furnace chamber of the steam-generating unit flow along the path indicated by the line *B-B* in the direction indicated by the arrowhead. Steam generated in that unit is superheated in the superheater (1), is partly expanded in the steam-turbine high-pressure stage (5), is reheated in the reheater (2), is further expanded in the turbine low-pressure stage (6), and is condensed in the condenser (7). The first steam bleed (60) heats air-heaters (40 and 32) and the feedwater heater (11). The second steam bleed (61) heats air-heaters (44 and 36) and feedwater heater (13). Condensate from the condenser (7) is fed through the feedwater heaters (11, 12 and 13) to the economiser (3) and thence to the steam-generating parts of the unit (not shown). Air from the forced-draught fan (20) is heated in the gas-heated air-heater (4), the steam-heated air-heaters (32, 34 and 36), and in the superheated steam-heated air-heaters (40, 42 and 44), and this heated air is fed to the combustion apparatus of the unit. *British Patent No. 866,342 issued to Babcock & Wilcox Limited. Complete specification published April 26th, 1961.*

G. & J. Weir Ltd. are to install another of their "Multiflash" sea-water distillation plants at Kuwait, Persian Gulf. The installation for the Kuwait Oil Co. Ltd. will be at Mina-el-Ahmadi, and will consist of a single 21-stage plant with an output of 600,000 imperial gallons per day of fresh water. The order follows the highly-successful commissioning of two similar installations last year, one of which was the world's largest "flash" type plant, for the Government of Kuwait, producing two million gallons daily. Erection of the new installation is to be completed during November this year—only 43 weeks from the date of order—and with its commissioning a month later, Kuwait will be using nearly four million gallons daily of fresh water from plant of Weir manufacture. The world total output of "Weirwater" will then reach over 11 million imperial gallons.

* * *

A £40,000 contract to install 132-kV cables at Kincardine generating station has been awarded to **Associated Electrical Industries Limited** by the South of Scotland Electricity Board. The contract involves the supply and installation by A.E.I. Construction (Cables and Lines) Division, of two 132-kV circuits of six single-core oil-filled cables between 240-MVA, 275/132-kV super-grid interbus transformers in a new 275-kV substation and an adjacent 132-kV substation, and one circuit of three 132-kV single-core oil-filled cables between the 132-kV substation and the termination of a 275-kV overhead line. This line, now under construction for operating initially at 132-kV, will link with the North of Scotland Hydro Electric Board's system in the vicinity of Abernethy. The contract also includes the supply and installation of approximately 7,400 yd. of low-voltage power, multicore and telephone auxiliary cables associated with the new 275-kV substation.

* * *

William Boby and Co. Ltd., water-treatment engineers, Rickmansworth, have been awarded a contract worth approximately £46,000 by the English Electric Co. Ltd., for the supply of two de-aerators for Blyth "B" power station. The plants will each de-aerate 2,250,000 lb./hr. of feedwater.

NOTES Personal AND Industrial

The appointments were recently announced of two new directors of I.C.I. Metals Division—**Mr. T. H. Gallie** (Overseas) and **Mr. J. H. R. Crane** (Copper Products). Mr. Gallie for the past two years has been metal sales manager, Midland Region. Mr. Crane was, for two years, titanium production manager, and was transferred in 1959, to Lightning Fasteners Ltd., Witton, as general manager.

* * *

The Cambridge Instrument Co. Ltd. announce the appointment of **Mr. K. J. Bush,** A.M.I.E.E., as assistant sales manager, mechanical thermometer division, Friern Park, N. Finchley. The appointments are also announced of **Mr. W. C. Orford, Mr. S. V. J. Crump** and **Mr. W. A. Hall** as assistant resident engineers at the company's branch offices in Nottingham, Bristol and Manchester respectively.

* * *

Fluidrive Engineering Co. Ltd. announce that **Mr. John Bilton** has been appointed chief engineer of the company and, in his new capacity, he will be responsible for test and engineering development in addition to the design and drawing offices. Mr. Bilton joined the Company in 1935 and, until his new appointment, was chief designer. **Mr. Maurice Mizen,** as chief test engineer, will be responsible, under Mr. Bilton, for both test-bed management and engineering development. Mr. Mizen has been with the company for 24 years. Another appointment is that of **Mr. John Elderton,** who becomes assistant chief engineer.

* * *

Ambuco Limited announce the appointment of **Mr. E. W. F. Clements,** M.Inst.C.E., M.I.Mech.E., as a director of the company. Mr. Clements is chief mechanical and electrical engineer of The Consolidated Gold Fields of South Africa Ltd. Also announced is the taking up, by **Mr. J. L. Webb,** of the position of contracts manager.

* * *

Mr. G. H. Thackrah, sales manager of Markland Scowcroft Limited, has been elected a director.

* * *

Associated Electrical Industries Ltd. has appointed **Mr. R. F. Marshall,** B.Sc.(Eng.), A.M.I.Mech.E., A.M.I.E.E., as central education manager, and **Mr. D. Baird,** B.A.(Hons.), B.Sc.(Lond.), as central personnel manager.

* * *

Crofts (Engineers) Limited, power transmission engineers, Thornbury, Bradford, announce the appointment of **Mr. John R. Mitchell** as technical representative for the Sheffield area.

* * *

Mr. D. J. Anelli has been appointed export manager of Geo. Salter & Co. Ltd., West Bromwich. He replaces **Mr. C. P. Turnbull,** who has left Salter to take up another appointment.

A. Reyrolle & Co. Ltd. announce that they have signed agreements with **Oliver J. Nilsen (Australia) Limited** for collaboration in the manufacture of high-voltage switchgear and ancillary equipment in Australia. It is proposed to form a new company, Reyrolle Nilsen (Australia) Pty. Ltd., with an authorised capital of £500,000, and register the office at 45, Bourke Street, Melbourne, Victoria. The first directors will be **Mr. Oliver J. Nilsen,** C.B.E. (chairman) and **Mr. O. V. A. Nilsen,** representing the Nilsen interests, **Mr. J. Bennett,** M.I.E.E., and **Mr. G. Robinson,** representing the Reyrolle interests, with **Mr. E. L. Cottrell** as secretary.

* * *

It is with regret that we record the death recently, of **Mr. R. J. Glinn,** B.Sc., M.I.Mech.E., who, until his retirement in 1955, was with Babcock & Wilcox Limited. After graduating at University College, London, with first class honours in mechanical engineering, Mr. Glinn obtained practical engineering experience in the Babcock works at Renfrew, Scotland, and at the works of the Babcock German company at Oberhausen. After military service during the first world war, he returned to Babcocks in London, where he occupied a senior position, and was active in the development of pulverised-coal-firing for steam generation purposes. He was well known for his outstanding work in boiler feedwater chemistry. Mr. Glinn was a member of the Admiralty Committee on boiler corrosion, and of the Industrial Water Committee of investigation set up by the British Iron and Steel Research Association. He also served on a number of committees of the British Standards Institution, and was for some time a member of the Council of the Institution of Mechanical Engineers.

* * *

The following have been appointed to the board of the Consolidated Pneumatic Tool Co. Ltd. **Mr. S. H. Ireland**—assistant managing director; **Mr. L. S. Bright**—financial director; and **Mr. A. O. Miller**—director.

* * *

It is with regret that we record the death recently of **Mr. F. B. Perry,** M.I.Mech.E., a director of Robey & Co. Ltd., Lincoln. Mr. Perry had been with the company for 53 years.

* * *

Film Cooling Towers (1925) Limited, Richmond, Surrey, have recently been awarded a £1¼ million contract for the construction of six large natural-draught cooling-towers for the Drakelow "C" power station at Burton-on-Trent. The contract will be carried out in partnership with J. L. Kier & Co. Ltd., for the Midlands Project Group of the Central Electricity Generating Board. It is believed that this contract is the largest cooling-tower contract ever to be placed.

Mr. J. H. Thornton, M.Inst.C.E., has been appointed group resident superintendent for the 580-MW nuclear power station at Sizewell, Suffolk, which is being built for the Central Electricity Generating Board, by the English Electric, Babcock & Wilcox, Taylor Woodrow atomic power group. Mr. Thornton was chief civil engineer in the group resident superintendent's department at the 500-MW nuclear power station at Hinkley Point (which the group is also building for the C.E.G.B.) from December, 1957, to December, 1959, and, from then until February 1st this year, has been assistant group resident superintendent. From 1946 to 1957 Mr. Thornton was senior engineer and resident engineer with Sir William Halcrow & Partners on the design and construction of hydro-electric projects for the North of Scotland Hydro-Electric Board.

* * *

Honeywell Controls Limited have removed from their Middlesbrough branch at Fletcher Street, to new premises at 59/60, Albert Road. Telephone number is unchanged, viz., Middlesbrough 4.43.31 and 4.43.32.

* * *

William Boby & Co. Ltd., Rickmansworth, Herts., have received a letter of intent for the supply, delivery and erection of four large de-aerators, one for each of the 500-MW turbo-alternator sets which the English Electric Company are building. The total contract value is expected to exceed £150,000.

* * *

The Drayton Regulator & Instrument Co. Ltd. announce that the name of the company has been changed to **Drayton Controls Limited.** The telephone number remains as before, viz. West Drayton 4012, but the telegraphic address is altered to Draycon West Drayton Telex.

* * *

Sir Noel Hall, M.A., and **Mr. L. W. Cole,** B.Com., have been elected directors of Babcock & Wilcox Limited. Sir Noel Hall was recently appointed Principal of Brasenose College, Oxford, having been principal of the Administrative Staff College, Henley, since 1946. He is a director of Fisons Limited. Mr. Cole, who has been in the service of Babcock's for over 30 years, became secretary of the company in 1952 and, in 1959, was made responsible for financial control within the Group. Mr. Cole will retain the position of secretary until December 31st, 1961.

* * *

The Ministry of Aviation have placed for the third consecutive year, a twelve-months' contract with **Combustion Chemicals Limited** for the supply of their product, Desulfurol, for the treatment of the heavy residual fuel-oil used on the La Mont high-pressure/hot water boilers at London Airport North.